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Miscellaneous faunal data on Odonata of Cambodia

Oleg E. Kosterin

Institute of Cytology & Genetics SB RAS, Acad. Lavrentyev ave. 10,
Novosibirsk, 630090, Russia;
Novosibirsk State University, Pirogova str. 2, Novosibirsk, 630090, Russia.
Email: kosterin@bionet.nsc.ru

Abstract

Miscellaneous faunal data on Odonata are presented from four parts of Cambodia: the Cambodian Plain around Siem Reap (2017-2019), a Phnom Tbeng foothill in Preah Vihear Province (19.06.2018), Mondulkiri Province (June 2018) and the O'Som village environs in Pursat Province (March 2019). *Macromia flavocolorata* is for the first time reported for Cambodia. Some remarks and interesting observations are provided.

Key words: Odonata, dragonflies, damselflies, fauna, Cambodia, Siem Reap Province, Preah Vihear Povince, Mondulkiri Province, Pursat Province

Introduction

In 2006-2019 I made 13 trips to Cambodia aimed to investigate hitherto very poorly known fauna of its Odonata. The faunal data obtained have been published mostly in International Dragonfly Fund Report journal (issues 29, 40, 42, 45, 67, 89, 98, 101, 105, 123, 129, 132), the flexible format of which allowed to extensively illustrate dragonflies and damselflies themselves as well as their habitats, while taxonomical papers concerning Cambodian Odonata were published in a number of journals. Some pieces of faunal data obtained before the pandemic break of these research remained unpublished and are presented herewith. They refer to the plains of Siem Reap Province between the Phnom Kulen Mts. and Lake Tonle Sap (mostly the temple area), a short stop at the Phnom Thmei foothill in Preah Vihear Province, new data from Mondulkiri Province and small data from Pursat Province.

I. Plains of Siem Reap Province

Siem Reap Province is situated in the north-west of Cambodia and is interesting for two unique natural objects, the great Lake Tonle-Sap and a small isolated plateau of the Phnom Kulen Mts. On my five trips in 2017-2019 I focused on investigation of their Odonata but also collected some data from the plains between them, mostly from the environs of Siem Reap City, where I was based, and also from the Angkorian temple complex. The area considered here extends from the West Baray Reservoir (103.76°E) in the west to Ben Melaea Temple (104.23°E) in the east and from Chreav village (13.31°N) in the south to the Siem Reap River at 13.49°N in the north. So outlined, it does not include the plains temporarily inundated by Lake Tonle Sap, considered in the paper devoted to the lake (Kosterin 2020a) and the Siem Reap River at and upstream of

Banteay Srey village flowing already on a plain but still close to the Phnom Kulen Mts, considered in (Kosterin 2020b), but includes Ben Melaea Temple area up to 43 km ENE of Siem Reap.

Although this area includes the famous temples of the Angkorian complex, just six communications reported some earlier findings of Odonata there, made in 1964 (Asahina 1967), 2003 (Seehausen et al. 2016), 2005-2006 (Benstead 2006), 2006 (Kosterin & Vikhrev 2006) and 2010 (Roland & Roland 2010; Roland et al. 2011). Here I present modest data mostly obtained in dry season, on February 21-March 1 of 2017 and November 1-10, 2018, with a minor addition of December 2019 and June 2018.

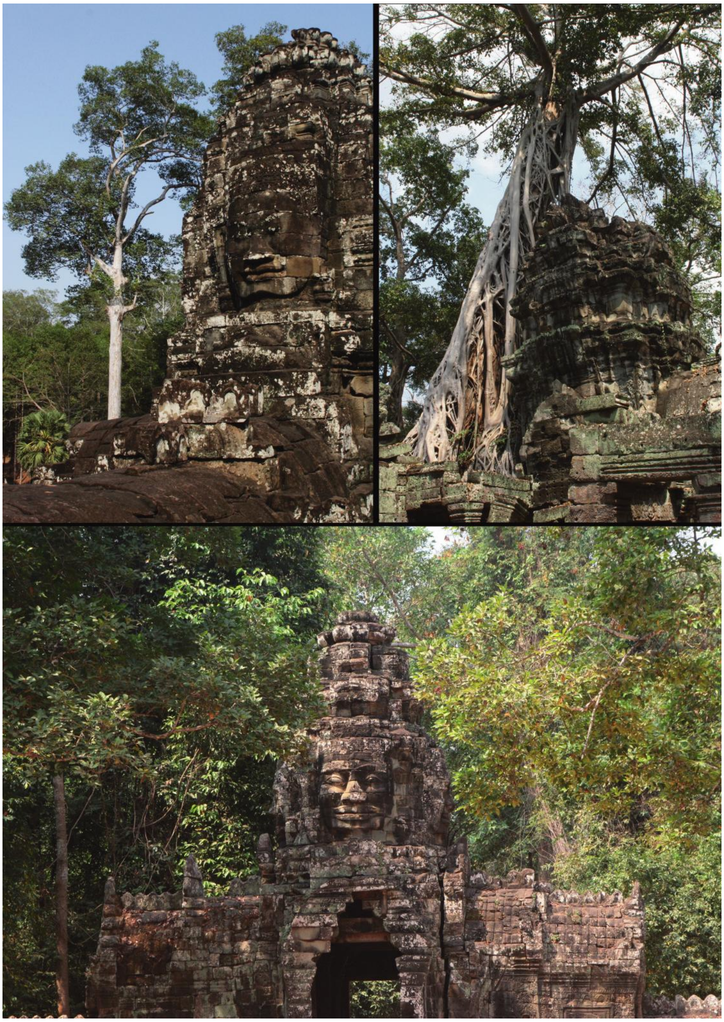

Figure 1. Semi-evergreen forest retained at Bayon (top left) and Banteay Kdel (top right and below) Temples. 22.02. 2017.

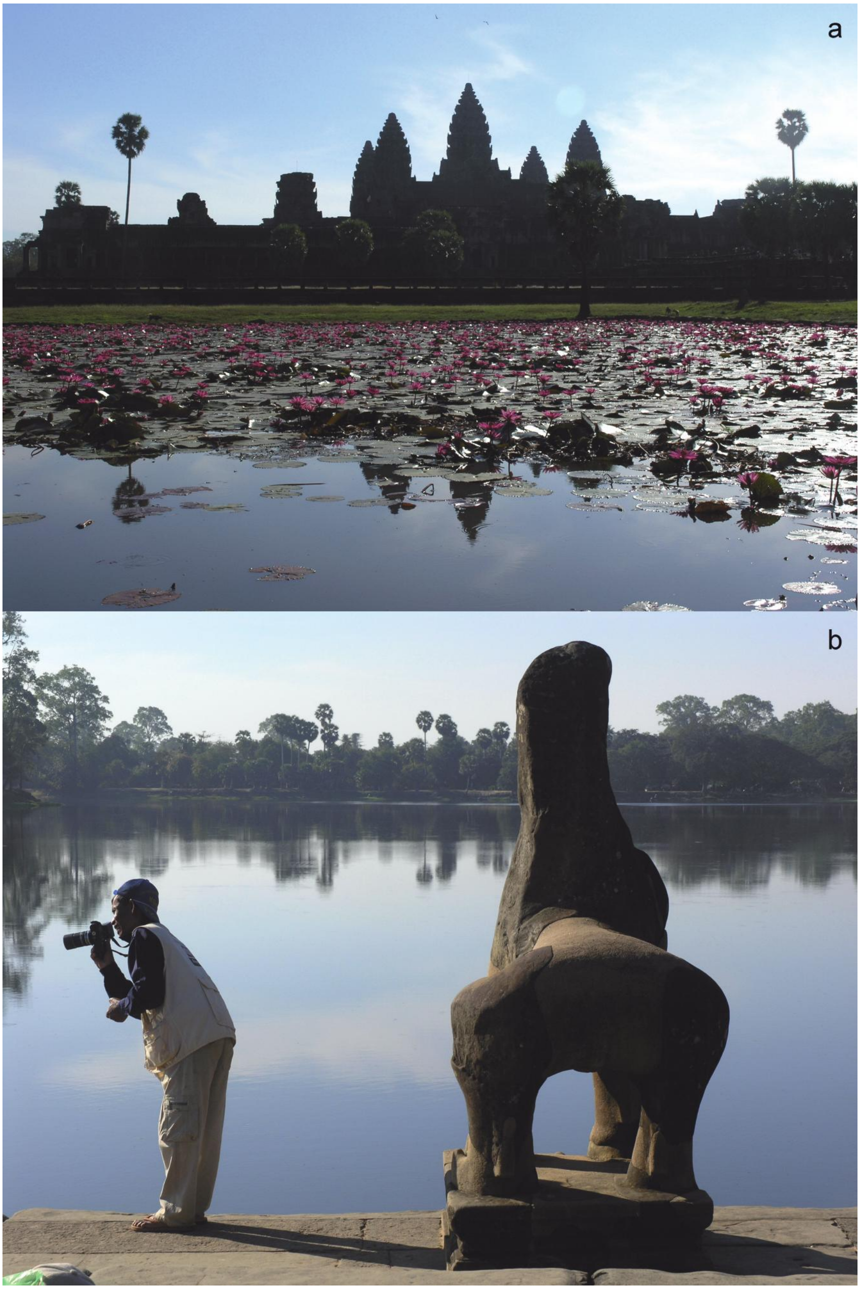

Figure 2. A pond (a) and the moat (b) at Angkor Wat Temple. 8.01.2006.

The vast area between Lake Tonle Sap and the Phnom Kulen Mts (37-50 km apart) is a farmland: mostly rice fields, some pastures, secondary tree growth, a lot of picturesque Palmyra Sugar Palm (*Borassus flabellifer* L.) growing semi-naturally (but having appeared in Cambodia only ca thousand years ago). At the same time tall semi-evergreen forest is retained in the territories of the famous temples of the Angkorian complex (Fig. 1), which also abound with ponds (Fig. 2a) and moats (Fig. 2b), good for lentic odonates.

Localities:

SR1: 2 km NE Preah Dak village, Prasat To ruins (two twin small towers, the most ancient pre-Angkorian relic). Secondary tree stand along the former wall of the ancient reservoir East Baray; a shallow ancient channel; a grassy swamp with grazing buffaloes in the former bottom, 13.456-457°N, 103.955-956°E, 30-31 m a.s.l. 21.02.2017.

SR2: the Siem Reap River 16 km NE of Siem Reap, at the bridge: deep and slow, with big bays, apparently dammed downstream, with turbid water; the high right bank with a clayey bluff and adjacent large bush thickets. 13.489-490°N, 103.921°E, 31-32 m a.s.l. 21.02.2017, 3.12.2018.

SR3: Sra Srang basin (Fig. 3) in the Angkor temple complex, with clear water and sandy banks, mostly barren but with sparse emerging grass at some places, 13.429-431°N, 103.903-904°E, 28-32 m a.s.l. 22.02.2017.

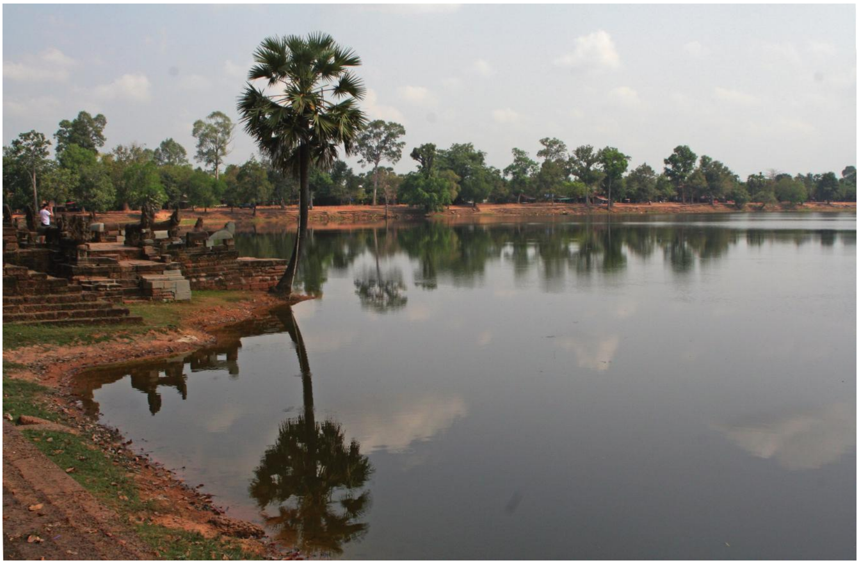

Figure 3. Sra Srang basin in the Angkor temple complex. 22.02.2017. Habitat of *P. rubriceps, I. decoratus, D. trivialis, O. sabina, T. pallidinervis*.

SR4: Banteay Kdel Temple, a muddy pool with emerging grass (including *Marsilea* sp.) in tall semi-evergreen dipterocarp forest. 13.430-431°N, 103.900-901°E, 30-35 m a.s.l. 22.02.2017.

SR5: Baphuon Temple, a sunny shallow grassy pool with flat banks in front of the entrance, with slime algae, *Ludwigia adscendens* (L.) H. Hara, *Ipomoea aquatica* Forssk, *Mimosa* sp., *Marsilea* sp., some dead bushes. 13.4440-4442°N, 103.8584-8586°E, 37 m a.s.l. 22.02.2017.

SR6: Very large swamps filled with lotus (*Nelumbo nucifera* Gaertn.) and/or water hyacinth (*Eichhornia crassipes* (Mart.) Solms) at the SW corner (230 m W to 390 m SW) of the West Baray Reservoir (Fig. 4). Some banks with a floating grassy bog with *Marsilea* sp.; some channels with clear water used for snakehead fishing. Secondary thickets, small pastures and long fallow lands, patches of dipterocarp forest at banks. 13.422-424°N, 103.761-763°E, 15-17 m a.s.l. 25.02.2017, 1 and 3.11.2018, 4.12.2019 (a very brief examination this day).

SR7: The S bank of the West Baray Reservoir. The bank is clayey, with very scarce grass and bushes of *Mimosa pigra* L., almost barren; the water is rather clear, deep already at the bank but very warm. Rather a lifeless place. 13.425°N, 103.764-785°E, 18-20 m a.s.l. 25.02.2017, 1.11.2018.

SR8: The outlet channel of the West Baray Reservoir, very deep with clear water and slow current, bordered by tall trees (Fig. 5). 13.420-425°N, 103.765-787°E, 18-20 m a.s.l., 25.02.2017.

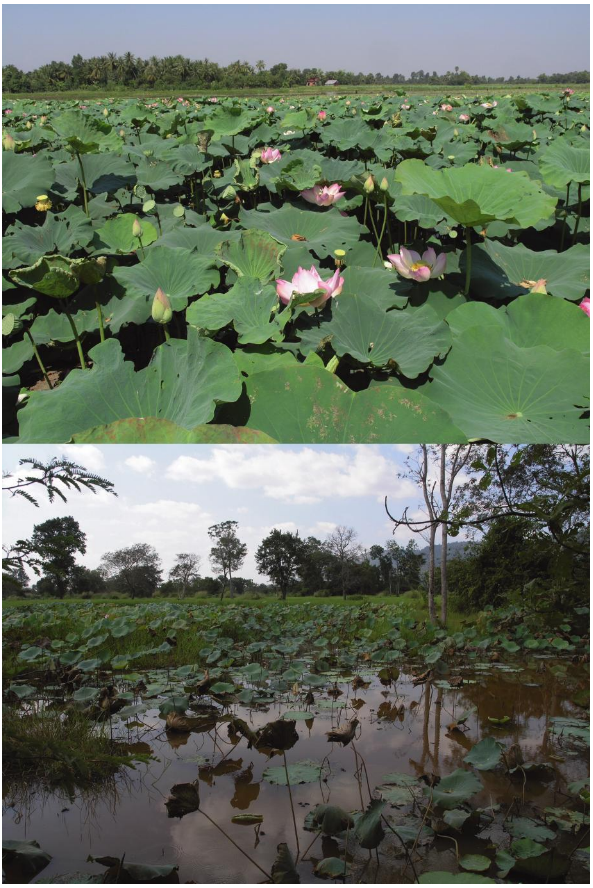

Figure 4. Large swamps at the SW corner of the West Baray Reservoir (SR6). 1. (above) and 3. (below). 11.2018. Habitat of not less than 14 odonate species (Table 1).

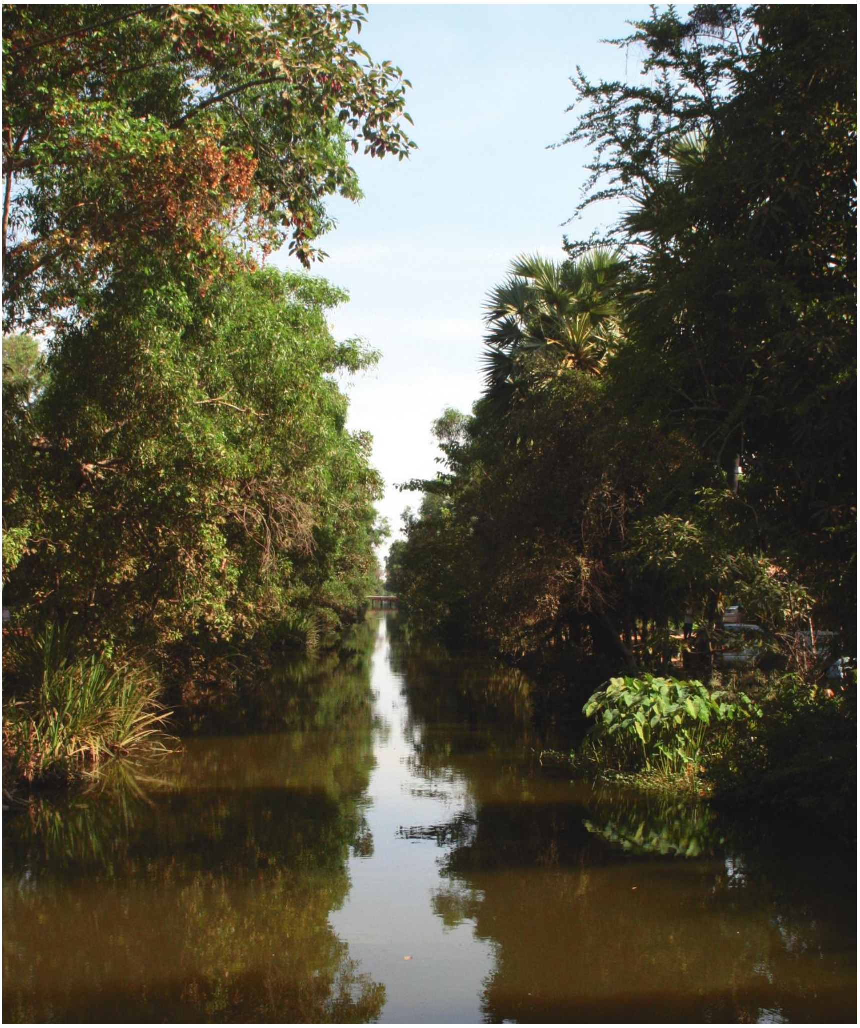

Figure 5. The outlet channel of the SW corner of the West Baray Reservoir (SR8). 25.02.2017. Habitat of *I. decoratus, B. contaminata, B. chalybea, N. tullia, O. sabina*.

SR9: a brook in a populated area, with a rust-coloured bottom, partly in open area trampled with cattle (with numerous frogs), partly shaded with secondary tree stand. 13.391-392°N, 103.860-861°E, 20-21 m a.s.l. 21.02.2017.

SR10: the Siem Reap River right bank in the Siem Reap City, at and upstream of the Night Market. The river is large and slow, the bank is shallow, at the time of examination covered with flowering semiaquatic *L. adscendens* (Fig. 6) and sparse *Nymphaea* sp. 13.353-355°N, 103.856-858°E, 20-21 m a.s.l. 21.02.2017.

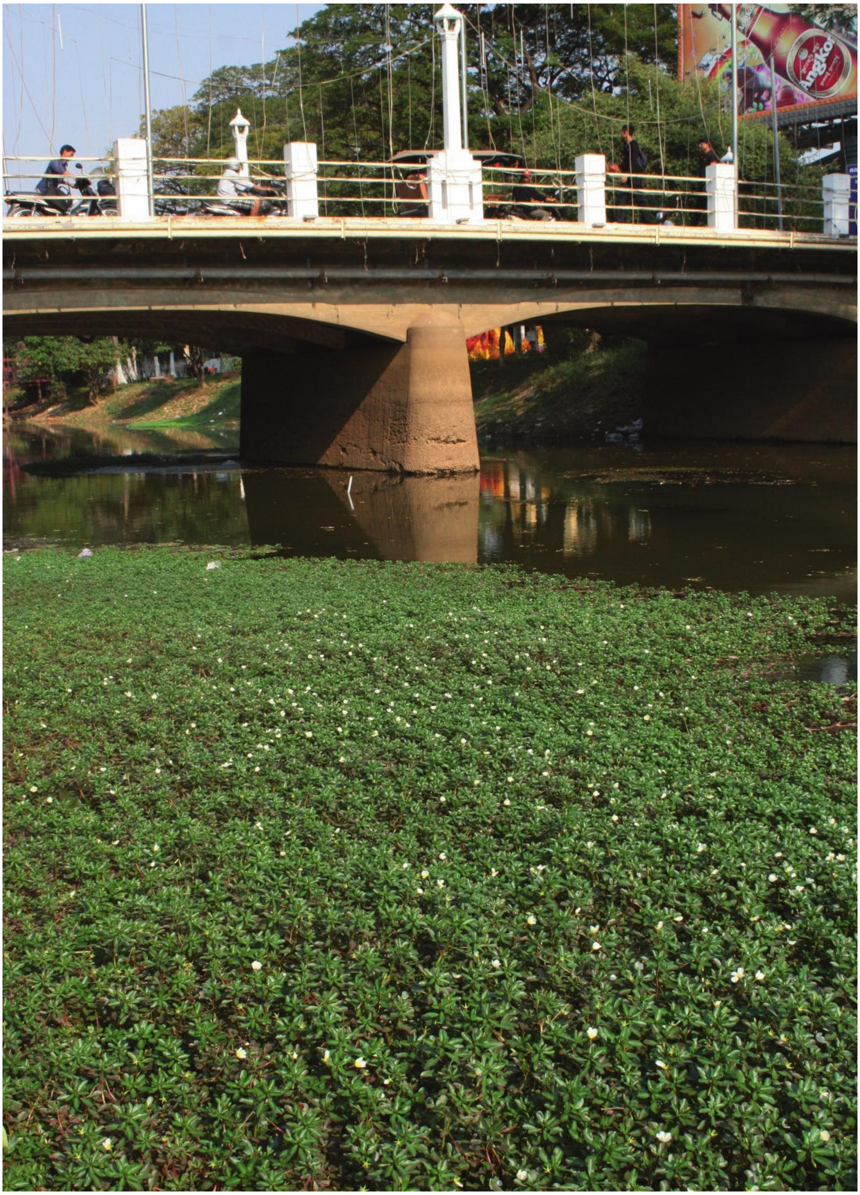

Figure 6. The Siem Reap River in the Siem Reap centre (SR10), with lot of *Ludwigia adscendens*. 21.02.2017. Habitat of *A. minima, A. pygmaea, I. senegalensis, P. microcephalum, A. panorpoides, B. contaminata, C. servilia, D. nebulosa, D. trivialis, R. phyllis, R. variegata, T. pallidinervis*.

SR11: a big pond at Chreav village, with grassy banks, a small floating bog at one of them and a lotus thicket at another, 5.5 km SE Siem Reap, 10.2 km NNE of the Lake Tonle Sap N bank. 13.320-321°N, 103. 885-886°E, 12-13 m a.s.l. 1.03.2017.

SR12: the remnants of an ancient channel used for transportation of rock blocks to the temple area (presently crossed with many dams). A broad tree-shaded part with high banks and brown sucking bottom; nearby an open shallow part with similar bottom overgrown with lotus. 13.4442°N, 104.1696°E, 3.12.2018.

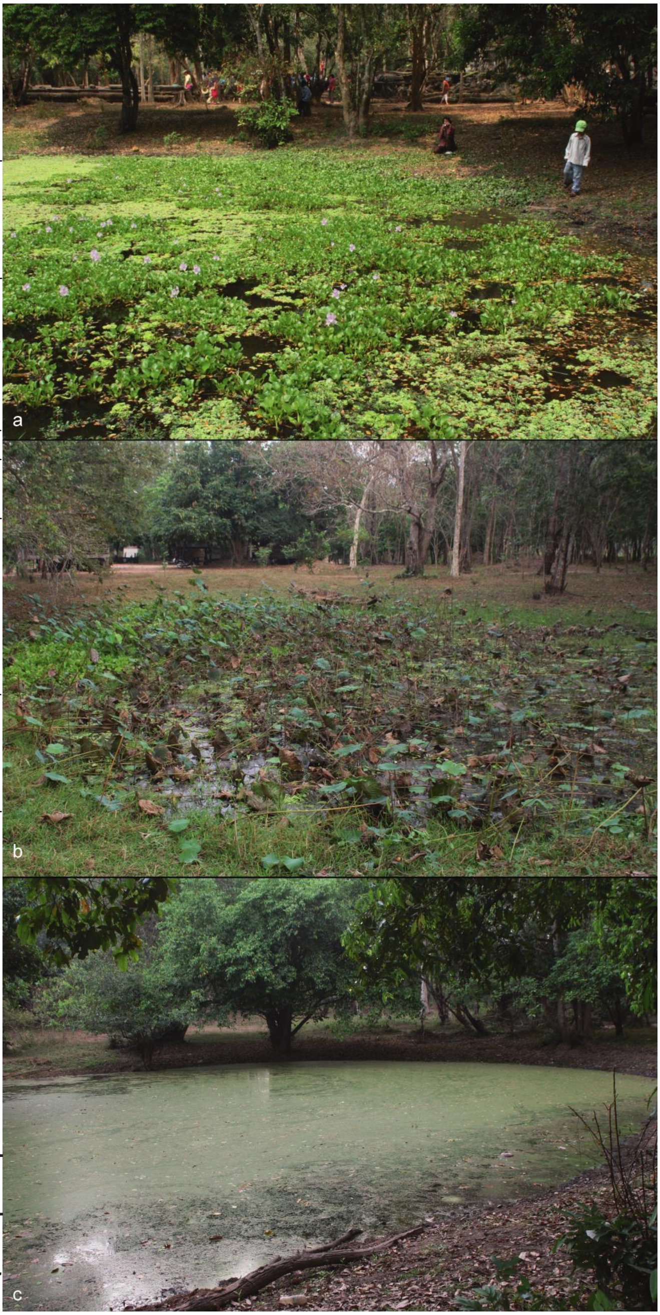

Figure 7. Close and of similar size but different ponds in front of Ben Melaea Temple (SR15); a – covered with water cabbage etc.; b – covered with lotus; c – with some *Azolla*. 27.02.2017.

SR13: the big O'Tma Dap River at the bridge near Ben Melaea Temple, with turbid water and high banks with secondary growth of trees and *Mimosa* sp. 13.4442°N, 104.1696°E, 19.06.2018.

SR14: The N moat of Ben Melaea Temple: a typical Cambodian small stream with a bed of sandstone rocks surrounded with trees, at the time of examination without current, with pools up to waist-deep. 13.479°N, 104.229°E, 81-82 m a.s.l. 27.02.2017.

SR15: Four small ponds at Ben Melaea Temple, some 20 m in diameter (Fig. 7). One of them was completely covered with water cabbage (*Pistia stratiotes* L.), with participation of water hyacinth, *Salvinia cucullata* Roxb., *L. adscendens* and *Nymphaea* sp. (Fig. 7a); another filled with lotus, with participation of water hyacinth and *L. adscendens* (Fig. 7b); the two other ones with almost open surface with some *Azolla* sp. (Fig. 7c). A lot of *Hylarana erythraea* (Schlegel, 1837) frogs at the two former ones. Surrounded with tall deciduous dipterocarp forest, drier than in the Siem Reap environs (Fig. 8): trees without leaves in February.13.4739-4744°N, 104.2272-2300°E, 80 m a.s.l. 27.02.2017.

SR16: The S moat of Ben Melaea Temple: a very broad and deep pond covered with floating grassy bog with participation of lotus and Colocasiae indet.; cleared from that vegetation for 20 m along the road, with open water with sparse lotus, water hyacinth and water cabbage. 13.472°N, 104. 229 °E, 80 m a.s.l. 27.02.2017.

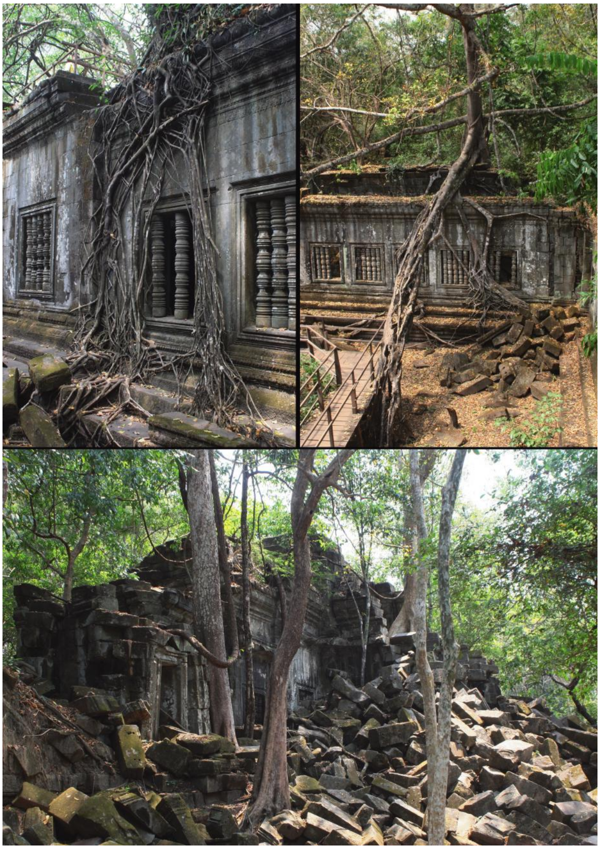

Figure 8. Dry forest at Ben Melaea Temple. 27.02.2017.

Results and Discussion. The Odonata observed, collected and photographed in the above listed localities are enumerated in Table 1. It includes 52 species well representing the most common ones in the Cambodian Lowland. *Camacinia gigantea* Brauer, 1867 is the only one which I have never seen in Cambodia before (three males perched high on dead bushes of *Mimosa pigra* (Fig. 14) above a shallow pond at Baphuon Temple (SR5) at midday, and one male was hovering at one place above the small pond covered with water cabbage at Ben Melaea temple (SR15) in the morning but was not seen at midday).

In 2017-2019 I did not come across four species earlier recorded in literature for the area considered. Asahina (1967) reported *Gynacantha subinterrupta* Rambur, 1842 and *Zyxomma breviventre* (Martin, 1921) (as *Zyxommoides breviventre*) from Angkor Wat, and the latter species also by Seehausen et al. (2016) by specimens attracted by light at two localities, of which one (Angkor Thom) was near SR5. *Aciagrion borneense* Ris, 1911 and *Tramea ?transmarina* (an unclear sighting) were reported from Angkor Wat Temple, and the latter species and *Lestes concinnus* Hagen in Selys, 1862 were reported from the Siem Reap Airport area by myself (Kosterin & Vihkrev 2006). Benstead (2006) reported *Ictinogomphus rapax* (Rambur, 1842) as ‘common’ in Angkor Wat versus *I. decoratus* (Selys, 1854) as ‘single’ there: no doubt those specimens were *I. decoratus* (while the Oriental *Ictinogomphus* spp. require a complete revision).

Photographs of not less than 17 more species were presented for the considered area in the Facebook group ‘Natural Cambodia’ by the small local naturalist community of Siem Reap City. There is no geolocation and some of the locality annotations are too general, e.g. ‘Siem Reap’ or ‘near Siem Reap’, which in fact could even refer to the Phnom Kulen Mts. with very different environmental conditions and odonate assemblage. But quite a number of good findings are well documented. These public science data will be summarised and published elsewhere.

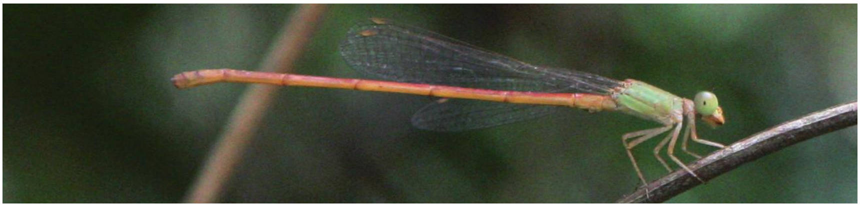

Figure 9. A mature male of *Ceriagrion olivaceum* at a forest pool in Banteay Kdel Temple territory (SR4). 22.02.2017.

Table 1. Odonata registered in the Siem Reap area (in locs SR1-SR16, see the text). The month of visit is indicated; the visits to SR2, SR6 and SR7 at different month are considered separately. Codes of abundance: - – not found, 1 – single individual found (sex indicated when clear), 2 – few (2 to 5 individuals, of any sex), 3 - moderately abundant (6-20), 4 – abundant (~20-100); underlining indicates that some specimen(s) was (were) collected at this locality, boldface – that the species was photographed in nature there; other registrations are sightings. The provenance of two species found beyond the coded localities is given in footnotes.

Localities	**SR1**	**SR2**	**SR2**	**SR3**	**SR4**	**SR5**	**SR6**	**SR6**	**SR6**	**SR7**	**SR7**	**SR8**	**SR9**	**SR10**	**SR11**	**SR12**	**SR13**	**SR14**	**SR15**	**SR16**
Month when visited	Feb.	Feb.	Dec.	Feb.	Feb.	Feb.	Feb.	Nov.	Dec.	Feb.	Nov.	Feb.	Feb.	Feb.	Mar.	Dec.	Jun.	Feb.	Feb.	Feb.
Calopterygidae																				
1. *Vestalis gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Chlorocyphidae																				
2. *Libellago lineata*	-	**1♀**	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lestidae																				
3. *Lestes elatus*[1]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coenagrionidae																				
4. *Aciagrion pallidum*	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
5. *Agriocnemis minima*	3	-	-	-	-	-	3	-	-	-	-	-	-	3	3	1♀	-	-	-	3
6. *Agriocnemis nana*	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. *Agriocnemis pygmaea*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-
8. *Ceriagrion auranticum*	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	2
9. *Ceriagrion cerinorubellum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♀	-	-
10. *Ceriagrion malaisei*[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. *Ceriagrion olivaceum*	-	-	-	-	**1♂ (Fig. 9)**	-	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-
12. *Ceriagrion praetermissum*	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	3	-	-	**2 (Fig10)**	-
13. *Ischnura senegalensis*	-	-	-	-	-	-	-	-	1♀	1♂	-	-	-	4	4	-	-	-	-	-
14. *Paracercion calamorum dyari*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
15. *Pseudagrion australasiae*	1♂	-	-	-	-	-	-	-	-	-	-	?2	-	-	3	2	-	-	-	-
16. *Pseudagrion microcephalum*	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
17. *Pseudagrion rubriceps*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Localities	SR1	SR2	SR2	SR3	SR4	SR5	SR6	SR6	SR6	SR7	SR7	SR8	SR9	SR10	SR11	SR12	SR13	SR14	SR15	SR16
Month when visited	Feb.	Feb.	Dec.	Feb.	Feb.	Feb.	Feb.	Nov.	Dec.	Feb.	Nov.	Feb.	Feb.	Feb.	Mar.	Dec.	Jun.	Feb.	Feb.	Feb.
Platycnemididae																				
18. *Copera marginipes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	**2**	1♂	-	-
19. *Onychargia atrocyana*	-	-	-	-	-	-	-	1♀	-	-	-	-	-	-	-	-	-	-	-	-
20. *Pseudocopera ciliata*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1♂	-	-	-
21. *Prodasineura autumnalis*	-	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-
Gomphidae																				
22. *Ictinogomphus decoratus melaenops.*	-	-	-	2	-	-	-	-	-	-	-	**2 (Fig. 11c)**	2	-	-	-	-	**2 (Fig. 11a-b)**	-	-
Macromiidae																				
23. *Epophthalmia frontalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-
Libellulidae																				
24. *Acisoma panorpoides*	-	-	-	-	-	-	3	1♀	-	-	-	-	-	2	1♀	-	-	-	-	-
25. *Aethriamanta aethra*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1♂ (Fig. 12a)**	2
26. *Aethriamanta brevipennis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	**2 (Fig. 12b)**	2
27. *Brachythemis contaminata*	-	4	-	4	-	-	2	4	-	4	-	2	2	**4 (Fig. 13)**	4	-	-	2	-	2
28. *Brachydiplax chalybea*	-	-	-	-	-	-	2	3	-	-	-	**1♂**	-	-	-	4	-	-	2	3
29. *Brachydiplax farinosa*	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
30. *Camacinia gigantea*	-	-	-	-	-	**2 (Fig. 14)**	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-
31. *Crocothemis servilia*	-	2	-	2	2	3	2	-	3	2	-	-	-	**3**	2	1♂	-	3	2	2
32. *Diplacodes nebulosa*	-	-	2	-	-	-	-	4	-	-	3	-	-	2	2	-	-	-	-	-
33. *Diplacodes trivialis*	-	1♂	-	1♂	-	-	-	4	-	-	3	-	-	1♂	-	-	-	-	-	-
34. *Hydrobasileus croceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-

Localities	SR1	SR2	SR2	SR3	SR4	SR5	SR6	SR6	SR6	SR7	SR7	SR8	SR9	SR10	SR11	SR12	SR13	SR14	SR15	SR16
Month when visited	Feb.	Feb.	Dec.	Feb.	Feb.	Feb.	Feb.	Nov.	Dec.	Feb.	Nov.	Feb.	Feb.	Feb.	Mar.	Dec.	Jun.	Feb.	Feb.	Feb.
35. *Lathrecista asiatica*	-	-	-	-	-	-	-	1♀	-	-	-	-	-	-	-	-	-	-	-	-
36. *Neurothemis fluctuans*	1♀	-	-	-	**2 (Fig. 15)**	-	-	2	-	-	-	-	-	-	-	1♂	-	-	-	-
37. *Neurothemis fulvia*	2	-	-	-	2	-	-	3	2	-	-	-	2	-	-	-	-	2	-	-
38. *Neurothemis intermedia atalanta*	-	-	-	-	1♀	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
39. *Neurothemis tullia*	2	-	2	-	**3**	-	2	4	2	1♂	-	-	-	-	2	-	-	-	1♀	2
40. *Orthetrum chrysis*	1♂	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1♂	-	-	-	-
41. *Orthetrum sabina*	2	-	2	**3**	2	-	2	-	3	3	3	3	2	-	2	3	-	2	2	2
42. *Pantala flavescens*	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	2	-
43. *Potamarcha congener*	-	-	**1♀**	-	-	-	1♀	-	-	-	-	-	1	-	-	-	-	1♂	1♂	-
44. *Pseudothemis jorina*	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-
45. *Rhodothemis rufa*	-	-	-	-	1♀	-	2	3	-	-	-	-	-	-	-	-	-	-	3	-
46. *Rhyothemis phyllis*	-	-	-	-	2	2	4	**4**	-	-	-	-	1	4	1	2	-	1	1	-
47. *Rhyothemis variegata*	-	-	-	-	2	2	4	**4**	-	-	-	-	1♀	**4**	-	1♀	-	-	-	-
48. *Tholymis tillarga*	-	-	-	-	**1♀**	-	-	1♀	3	3	-	-	-	-	-	-	-	-	-	1♂
49. *Trithemis aurora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
50. *Trithemis pallidinervis*	-	3	2	1	-	3	-	-	-	4	-	-	-	2	1♂	-	-	-	-	-
51. *Urothemis signata*	-	-	-	-	-	-	2	-	2	-	3	-	-	-	1♂	2	-	-	2	3
52. *Zyxomma petiolatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?1	**1♀ (Fig. 16)**	-	-	-

1 A male was found at 2 a.m. on 21.12.2019 attracted by light to Damnak Riverside Guesthouse in Siem Reap (13.3505° N, 103.8557° E)
2 A male collected at Phnom Bakeng on 11.95.2018 was offered by Christophe Guenole

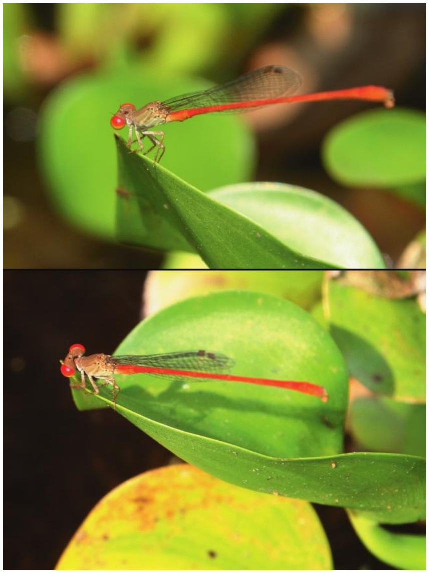

Figure 10. A male of *Ceriagrion praetermissum* at a pond with water cabbage in front of Ben Melaea Temple (SR15) (Fig. 7a). 27.02.2017.

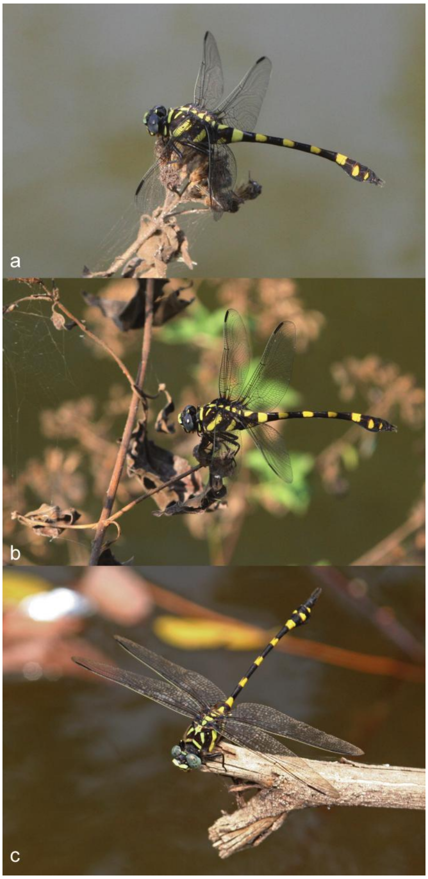

Figure 11. *Ictinogomphus decoratus melaenops*: a-b – a female at the West Baray outlet channel (SR8; Fig. 5), 25.02.2017; c – a male at Ben Melaea Temple northern moat (SR14), 27.02.2017.

Remarks. 1. The male of *Ceriagrion olivaceum* Laidlaw, 1914 collected on 23.02.2017 at SR4 looked somewhat 'too colourful' for this mostly dull-coloured species as having the abdomen reddish above and the thorax distinctly greenish (Fig. 9). However, I have seen at least one such specimen at Pattaya, Thailand (considered as *C. ?indochinense* in Kosterin & Vikhrev 2008), and the reddish abdomen is mentioned in literature on this species. It seems that this is a coloration of fully adult males of this species while an observer more frequently sees immature males and females on their dispersal from water, which are dull ochraceous indeed.

2. A male of *Neurothemis fluctuans* (Fabricius, 1793) photographed at Banteay Kdel Temple (SR4) had the wing coloration unusual in being very uneven, slight at wing bases and becoming earthy-blackish to the outer margins of the coloured area, which was shorter than usual in this species, not reaching the pterostigmata (Fig. 15). This appearance could even suggest a possible introgression from *N. tullia* (Drury, 1773), although the body was coloured normally for young *N. fluctuans*.

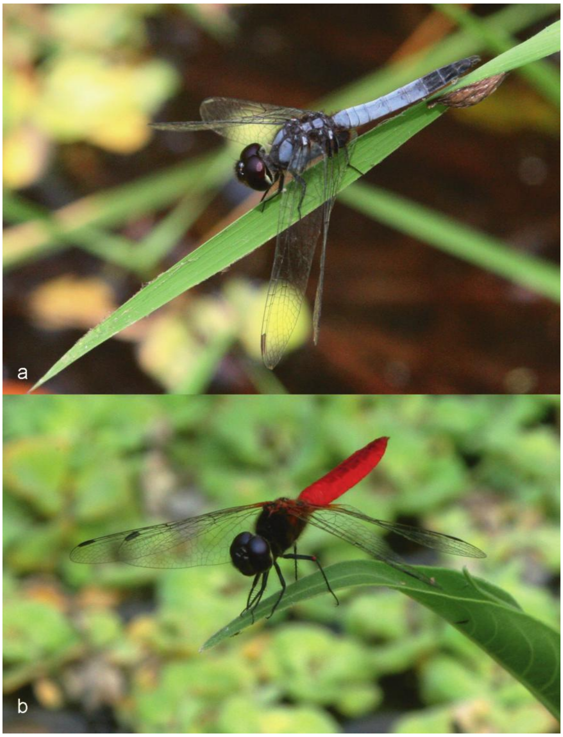

Figure 12. Males of *Aethriamanta aethra* (a) and *M. brevipennis* (b) at the pond with water cabbage in front of Ben Melaea Temple (SR15) (Fig. 7a), 27.02.2017.

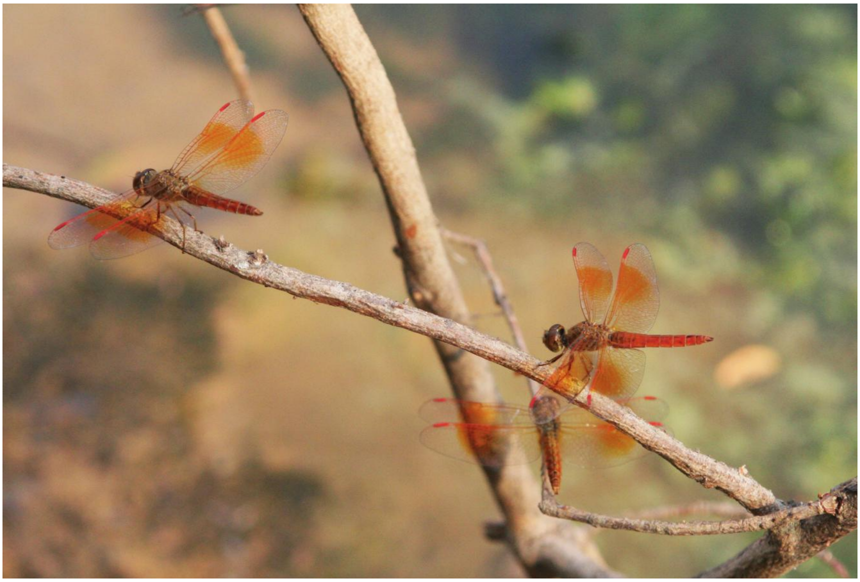

Figure 13. Males of *Brachythemis contaminata* at the Siem Reap River in the Siem Reap centre (SR10) (Fig. 6), 21.02.2017.

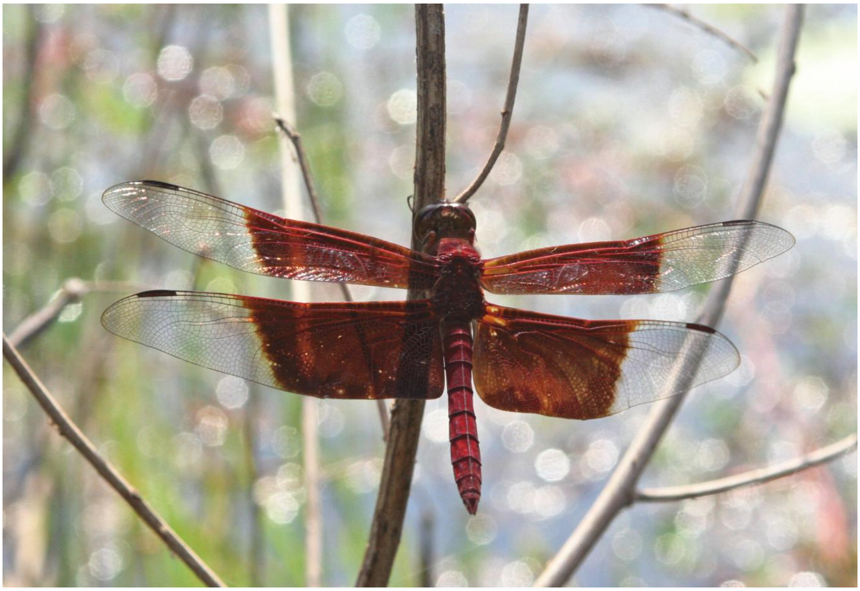

Figure 14. A male of *Camacinia gigantea* at a pond at Baphuon Temple (SR5). 22.02.2017.

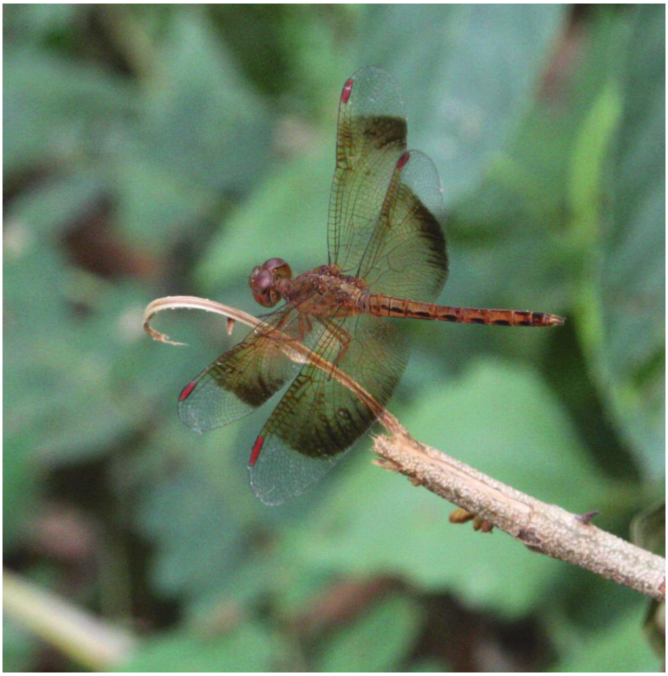

Figure 15. A young male of *Neurothemis fluctuans* with an unusual wing coloration in the forest in the Banteay Kdel Temple territory (SR4). 22.02.2017.

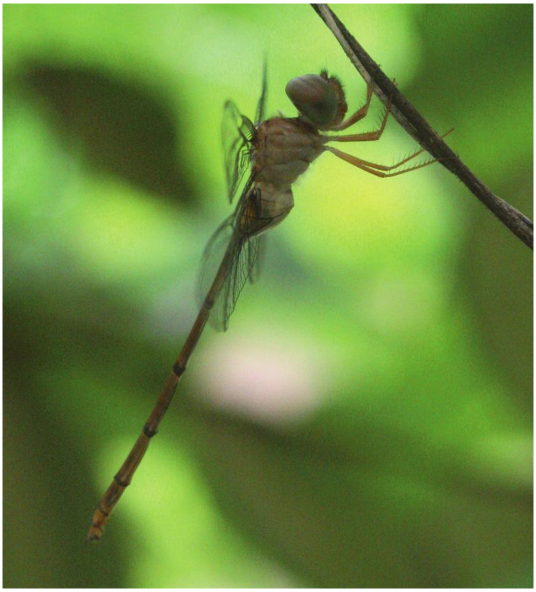

Figure 16. A female of *Zyxomma petiolatum* in thickets at the O'Tma Dap River right bank near the bridge (SR13). 19.06.2018.

Observation. It was remarkable how the four small, shallow pools situated very closely to each other at Ben Melaea Temple (SR15) differed in both vegetation (Fig. 7) and odonate communities (by 27.02.2017). The surface of two of them had scarce *Azolla* (Fig. 7c); the dragonflies were represented by few males of *Brachydiplax chalybea* Brauer, 1868, *Crocothemis servilia* (Drury, 1770), *Pantala flavescens* (Linnaeus, 1758), *Orthetrum sabina* (Drury, 1779) and one soaring male of *Hydrobasileus croceus* (Brauer, 1867). The surface of another one was completely covered with water cabbage (Fig. 7a) and it offered a rich odonate assemblage including several *Ceriagrion praetermissum* Lieftinck, 1929 (Fig. 10), *Aethriamanta brevipennis* (Rambur, 1842) (Fig. 12b), *C. servilia*, *Urothemis signata* (Rambur, 1842) and singular males of *Aethriamanta aethra* (Ris, 1912) (Fig. 12a), *Camacinia gigantea* Brauer, 1867, *Potamarcha congener* (Rambur, 1842), *Rhyothemis phyllis* (Sulzer, 1776). Besides, in the morning a small black-winged libellulid oviposited between the water cabbage rosettes, which may have been an androchromatic female of *N. tullia*. The rest pool was overgrown with tall lotus (Fig. 7b) and inhabited almost exclusively by plentiful *Rhodothemis rufa* (Rambur, 1842) (these dragonflies mostly perched on the lotus petioles keeping their abdomen oriented along the latter), along which I found only a male of *B. chalybea* and a teneral male of *C. praetermissum*.

II. Phnom Tbeng foothill

Phnom Tbeng is a narrow curved plateau ca 40 km long and 12 km wide at the broadest place, with the highest place ca 490 m a.s.l. and very steep N and E slopes; at its eastern foot the Preah Vihear Province capital, Tbeng Meancheay City (Krong

Preah Vihear) resides. The plateau is covered with dense, rather undisturbed evergreen forest. It quite resembles the Phnom Kulen Mts in Siem Reap Province (Kosterin 2020b) but is almost unexplored, that is surprising even in spite of its being Phnom Tbeng Natural Heritage Park. About midday 19.06.2018 we had a very short, ca half an hour stop at the base of its N slope, at 13.7771°N, 104.8703°E, ~140 m a.s.l., 12 km WSW Tbeng Meanchay City. This stop is worth mentioning since a rare dragonfly was photographed. I found a tiny turbid brook flowing from a shady pool under a picturesque vertical cliff and startled a greenish-greyish aeshnid female with a yellow face which sat on a dry branch above the pool. It was cautious and when disturbed it relocated to a nearby branch in a rounded niche in the rock. I took a photo (Fig. 17), then returned to the car for a net and came back but missed the stroke. Although the photo is poor, it shows the main veins suggesting Gynacanthinae (unfortunately it does not show crossveins). *Gynacantha* is excluded because of a cylindrical abdomen without waist, *Tetracanthagyna* because of a modest size, by exclusion the photo suggests *Heliaeschna*. *H. crassa* Krüger, 1899 is excluded because of missing dark strokes at the wing bases and, again, by smaller size, *H. uninervulata* (Martin, 1909) is excluded because greenish tones are very scarce. The dull grey body with scarce greenish tone at S1-S2 and yellow face suggest *H. simplicia* (Karcsh, 1891), so far known from Cambodia by a single male from Koh Kong Province (Kosterin & Chartier 2014). Of other Odonata only several individuals of *Vestalis gracilis* (Rambur, 1842) were seen at that place.

III. Mondulkiri Province

Odonata of Mondulkiri Province were studied by me for ten days in June 2014, the results being reported detail in Kosterin (2016, plus a number or taxonomic papers referenced therein). On June 23-28, 2018 I revisited mostly the same area but also examined some places further north-east. The earlier published results of that trip include the description of *Macromidia genialis buusraaensis* Kosterin 2018 (Kosterin 2018a), rediscovery of *Lestes nigriceps* Fraser, 1924 (Fig. 18) (Kosterin 2018b) and an update to the knowledge, with a female description, of *Microgomphus alani* Kosterin, 2016 (Kosterin 2019). The detailed description of the terrain is given in (Kosterin 2016). Of 16 localities examined in 2018, 4 were also studied in 2014 (Kosterin 2016), while 12 were studied anew (see below).

Localities:

M1: 12.5 km SSW of Sen Monorom, 3 km NE of O'Rang village, a rivulet making a loop on an open area bordered with trees, flowing slowly through low Poaceae grass, 12.3463-3468°N, 107.1704-1708°E, 678-680 m a.s.l. 28.06.2018.

M2: 11.5 km S of Sen Monorom, 5 km NE of O'Rang, a deep and fast river meandering in open grassland at the bridge. It falls via a small waterfall into a pool with high earthy banks and then hides in forked ferns and trees, 12.3586°N, 107.1822-1829°E, 682 m a.s.l. 28.06.2018.

M3: 6 km S of Sen Monorom, the waterfall at the O'Romis river (upstream of the power station) and the river upstream, with evergreen forest on the banks, 12.4064°N, 107.1780°E, 657 m a.s.l. 28.06.2018.

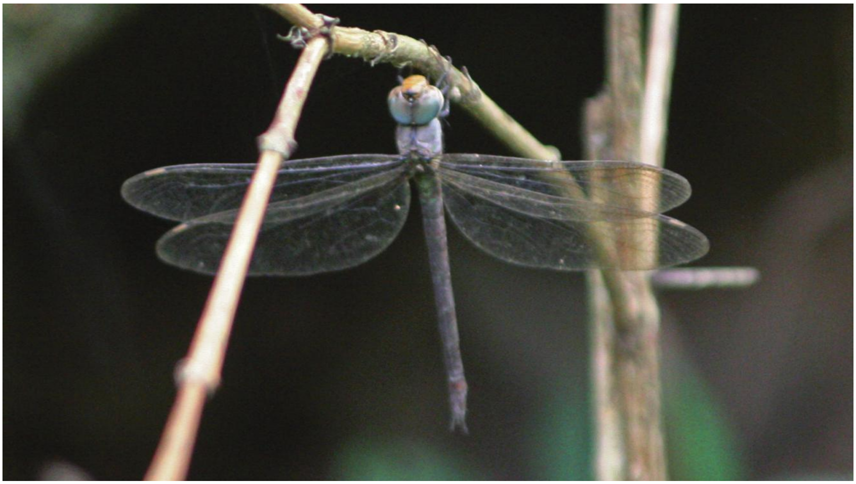

Figure 17. A female of *Heliaeschna simplicia* at a pool under a cliff at the Phnom Tbeng northern foot clad with evergreen forest. 19.06. 2018.

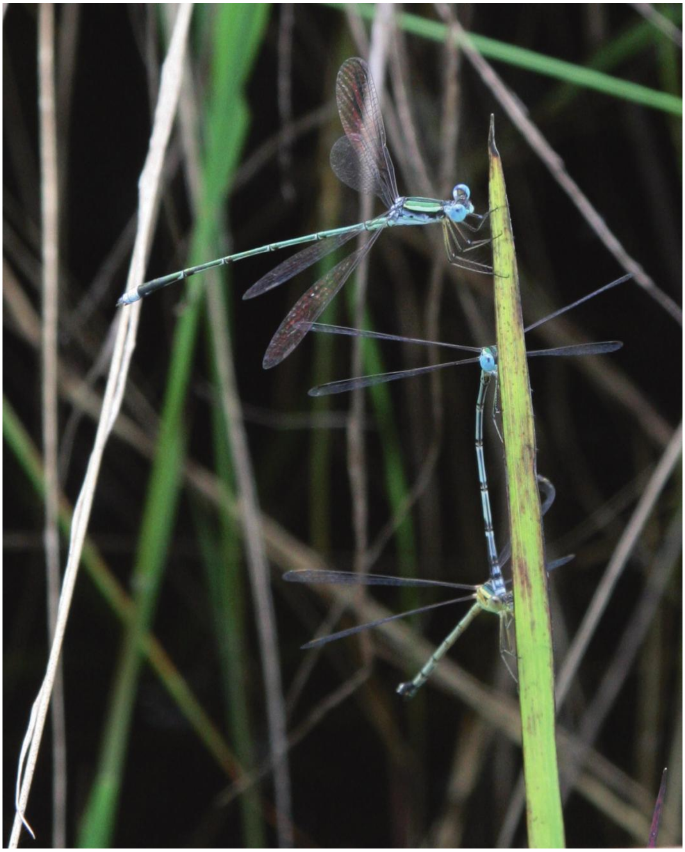

Figure 18. A male and tandem of *Lestes nigriceps* at a large grassy swamp 15 km NNE of Sen Monorom (M12). 27.06.2018.

M4: 5.3 km S of Sen Monorom, the fast, turbid O'Romis River, with a concrete dam forming a small reservoir at a cleared damp grassy area, 12.4116°N, 107.1834°E, 672 m a.s.l. 28.06.2018.

M5: 4.7 km S of Sen Monorom, the O'Romis River valley upstream of the road, hidden in the forest, with a grassy slope with open tree stand; its tributary brook weakly flows in a low forest through a chain of pools separated with tree roots, 12.4172-4186° N, 107.1907-1937° E, 688-690 m a.s.l. 28.06.2018.

M6: a rivulet 4 km SE Sen Monorom, 'Culminicola Rivulet', Loc. 7, in Kosterin (2016: fig. 10); in 2018 mostly destroyed, with the valley now partly occupied with a pepper plantation and the forest removed; the river is somewhat dammed, slow and turbid, with a short more or less natural section with grassy banks, with tall bamboo thickets at the dammed part. 12.4453° N, 107.2203-2210° E, 692 m a.s.l. 23.06.2018.

M7: the same rivulet more downstream, rivulet 2.5 km SE Sen Monorom, flows from a concrete dam in a narrow valley through bamboo thickets; on its left bank slope there is a grassy bog with water seeping through. 12.4493°N, 107.22074°E, 682 m a.s.l., 23.06.2018.

M8: the river with the Monorom Waterfall (Loc. 4b in Kosterin 2016: fig. 8), A relatively large river with rapids and the forested left bank and partly a strip of shady forest and a road at the right bank; examined downstream of a large reservoir and upstream of the hydropower station using the energy of water flowing from the reservoir through a collateral channel. 12.442-443°N, 107.159-161°E, 610-620 m a.s.l. 23.06.2018.

M9: a rivulet near Monorom Waterfall, 'Ochracea rivulet', Loc. 4a in (Kosterin 2016). A fast rivulet 2-3 m wide, with some rapids, surrounded partly by forest patches, partly by bamboo thickets. Its valley was almost undisturbed in 2014 but in 2018 only a short natural section was left in the lowermost reaches, upstream a road with a bridge appeared, a banana plantation and a pond (see below). Most probably these changes resulted from the cessation of elephant entertainment at the waterfall. 12.4404-4421°N, 107.1608-1617°E, 631 m a.s.l. 23.06.2018.

M10: a small pond with a grassy open area and a small plantation on the above rivulet (M9), 12.4415° N, 107.1618°E, 633 m a.s.l. 23.06.2018.

M11: 3.3 km NE of Sen Monorom, a big pond with a firm bottom and the banks partly barren, partly grassy with tall bamboo thickets and forest patches and with a small grassy bog (with *Nepenthes mirabilis* (Lour.) Rafarin and *Arundina graminifloia* (D. Don) Hochr.). Scarce water hyacinth and *Salvinia cucullata* on the water surface. 12.476°N, 107.211°E, 698 m a.s.l. 22 and 24.06.2018.

M12: 15 km NNE of Sen Monorom, a large, shallow sedgy (mostly ?*Carex* sp., with participation of ?*Eleocharis* sp. and *Cyperus* sp.) swamp (Kosterin 2018b: fig. 7) situated in a broad opening of a deciduous dipterocarp forest on a narrow, moderately elevated (455 m a.s.l.) plateau. At the middle there is a long knee-deep area of open water with floating *Nymphoides* (?*indica*), and a ditch along the road. (The satellite image of 2012 at Google Earth made before the construction of the road shows the opening small and hardly traceable, suggesting existence a forest swamp at that place and subsequent logging.). 12.5771°N, 107.2587°E, 455 m a.s.l., 27.06.2018.

M13: 16 km NNE of Sen Monorom, a large, deep and broad valley with a broad stony bed (Kosterin 2018a: fig. 12), with frequent stones of a porous igneous rock, which did not correspond to a weak brook (sometimes disappearing in the ground) flowing through and connected some quite deep pools (maybe the river was dammed upstream); bamboo thickets, *Mimosa pigra* bushes, and remnants of evergreen forest at the banks. 12.584-587°N, 107.253-256°E, 400-420 m a.s.l. 26-27.06.2018.

M14: 16 km NNE of Sen Monorom, 5.3 km SE of Pou Chhrey, a dammed lake-like but long river reach, up to waist-deep, with a firm bottom, broad floating carpets of *Ipomoea aquatica* along banks and *Persicaria* sp. with white flowers emerging at shallow places. 12.588-590°N, 107.24° E, 405 m a.s.l. 27.06.2018

M15: 12-13 km NE of Sen Monorom, the ?Pulung River (Loc. 11, 'Kruegeri River', in Kosterin 2016: fig. 11), about knee-deep, fast flowing in a rocky bed through a flat terrain with open deciduous dipterocarp forest; examined between the bridge and the right tributary upstream of it. 12.5194-5221°N, 107.2907-2931°E, 529-530 m a.s.l. 25.06.2018.

M16: 12.8 km NE of Sen Monorom, lower reaches of a brook – right tributary of the above mentioned ?Pulung River (Kosterin 2018a: fig. 11). 12.5186-5221°N, 107.2931-2954°E, 529-544 m a.s.l. 25 and 27.06.2018.

M17: a brook downstream (500 m W to NW) of the Buu Sraa Waterfall ('Loringae brook'; Loc. 13a-c, in Kosterin 2016: figs 13-15). A meandering brook with partly silty and partly stony bed with rapid sections and pools, shaded by tall forest (with traces of old fire) and tall bamboo thickets, often crossed with fallen trees. There is quite high a waterfall at the upstream end of the studied section; at the mouth it crosses an open grassy gentle right bank of the main river with open tree stand, 12.5673-5724°N, 107.4139-4173°E, 416-490 m a.s.l. 24.06.2018.

Results and Discussion. The Odonata observed, collected and photographed in the above listed localities are presented in Table 2, including 87 identified species, 2 unidentified species and one, *Tetrathemis ?platyptera* Selys, 1878, provisionally identified because it is known to be common in Mondulkiri Province (Kosterin 2016), with others not reported. These 90 species have been registered in just 6.5 days. Earlier I reported from this province 106 species recorded in 10 days (ca 17% more species for ca 53% more time). One can see how the savannah-clad plateau of Mondulkiri Province is richer than the above considered Cambodian Lowland around Siem Reap (with comparable areas examined), where I found 52 species in 7 days, that is ca 43% less for about the same time. Moreover, the Phnom Kulen Plateau situated in the same Siem Reap Province and clad with evergreen forest for years of observations revealed 97

Table 2. Odonata registered in Mondulkiri Province (locs M1-M16, see the text) on June 22-28, 2018. Codes of abundance: - – not found, 1 – single individual found (sex indicated when clear), 2 – few (2 to 5 individuals, of any sex), 3 - moderately abundant (6-20), 4 – abundant (~20-100); underlining indicates that some specimen(s) was (were) collected at this locality, boldface – that the species was photographed in nature; other registrations are sightings.

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
Calopterygidae																	
1. *Neurobasis chinensis*	-	-	**1♀**	-	-	1♂	-	-	2	-	3	-	3	-	-	-	-
2. *Vestalis gracilis*	-	2	-	2	-	2	2	-	4	-	3	-	2	1	-	3	3
Epallagidae																	
3. *Euphaea inouei*	-	1♂	-	2	1♂	-	-	4	4	-	-	-	**4 (Fig. 20a)**	-	2	**3 (Fig. 20b)**	**4 (Fig. 19)**
4. *Euphaea sanguinea*	-	-	-	-	-	-	2	2	3	-	-	-	-	-	-	-	-
Chlorocyphidae																	
5. *Aristocypha fulgipennis*	-	-	3	-	-	-	-	1♂	-	-	-	-	-	-	-	2	3
6. *Libellago lineata*	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
7. *Heliocypha biforata*	-	-	-	2	-	-	-	3	-	-	-	-	3	-	-	3	3
8. *Heliocypha perforata limbata*	-	-	-	-	-	-	-	3	-	-	-	-	**2**	-	2	-	3
Phylosinidae																	
9. *Rhinagrion hainanense*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Lestidae																	
10. *Lestes nigriceps*	-	-	-	-	-	-	-	-	-	-	-	**4 (Fig. 18)**	-	-	-	-	-
11. *Lestes praemorsus decipiens*	-	-	-	-	-	-	-	-	-	-	-	**4 (Fig. 21)**	-	-	-	-	-
Coenagrionidae																	
12. *Aciagrion approximans*	2	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-
13. *Agriocnemis nana*	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-
14. *Argiocnemis rubescens rubeola*	-	-	-	-	-	-	-	-	-	-	-	**2 (Fig. 22a)**	-	2	-	-	-
15. *Ceriagrion auranticum*	-	-	-	-	-	1♂	-	-	-	-	-	2	-	-	-	-	-
16. *Ceriagrion azureum*	-	-	-	-	-	-	-	-	-	-		1♀	-	-	-	-	-
17. *Ceriagrion cerinorubellum*	-	-	-	-	-	-	-	-	-	-	1♀	1♀	-	-	-	-	-

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
18. *Ceriagrion indochinense*	1♂	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-
19. *Ischnura senegalensis*	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-
20. *Mortonagrion aborense*	3	-	-	-	-	-	-	1♂	1♂	-	-	-	-	-	-	-	-
21. *Pseudagrion australasiae*	-	-	-	-	-	-	-	-	-	-	1♂	1♂	-	3	-	-	-
22. *Pseudagrion microcephalum*	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
23. *Pseudagrion pruinosum*	-	-	-	-	-	1♂	1♂	-	-	-	-	-	-	-	-	-	-
24. *Pseudagrion rubriceps*	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
Platycnemididae																	
25. *Coeliccia poungyi dasha*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
26. *Coeliccia rolandorum*	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	-	-	2
27. *Copera marginipes*	2	2	-	2	-	**3**	-	1♂	1♂	-	-	-	3	3	1♂	2	2
28. *Pseudocopera ciliata*	1♀	-	-	-	-	1♂	-	-	-	-	4	-	-	-	1♀	-	-
29. *Prodasineura autumnalis*	-	-	2	2	-	-	-	4	4	-	-	-	3	3	3	3	3
30. *Prodasineura doisuthepensis*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
31. *Prodasineura* sp., *verticalis* sensu Asahina, 1984	2	3	-	-	1♀	-	-	-	-	-	-	-	-	-	-	-	-
Platystictidae																	
32. *Protosticta* cf. *caroli*	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	-	-	2
Aeshnidae																	
33. *Anax guttatus*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	
34. *Gynacantha subinterrupta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1♀**
35. *Tetracanthagyna waterhousei*	-	-	-	-	-	-	-	-	-	-	-	-	1♀ (Fig. 23)	-	-	-	-

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
Gomphidae																	
36. *Asiagomphus reinhardti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2 (Figs 24-25)**
37. *Burmagomphus asahinai*	-	-	-	-	-	-	-	-	**1♂**	-	-	-	-	-	-	-	-
38. *Burmagomphus divaricatus*	-	-	-	-	1♂	-	-	-	1♂	1♀	-	-	-	-	-	-	-
39. *Euthygomphus schorri*	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	-	-
40. *Euthygomphus yunnanensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂
41. *Gomphidia* sp.	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	2	-	-
42. *Gomphidictinus perakensis*	-	-	-	-	-	-	-	-	**1♂**	-	-	-	-	-	-	2	**3**
43. *Ictinogomphus decoratus melaenops.*	-	-	-	-	-	-	-	-	-	2	-	1♂	2	3	-	-	-
44. *Lamelligomphus castor*	-	-	-	-	-	-	-	-	1♂	-	-	-	2	-	-	**2 (Fig 26)**	3
45. *Macrogomphus kerri*	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	-	**1♂**
46. *Microgomphus alani*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1♂	-
Macromiidae																	
47. *Epophthalmia frontalis*	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
48. *Macromia flavocolorata*	-	-	-	-	-	-	-	-	**3 (Figs 27-28)**	-	-	-	-	-	-	-	-
49. Gen. sp.	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-
Synthemistidade																	
50. *Idionyx thailandica*	-	1♂	-	-	2	-	-	-	-	-	-	-	1♀	-	-	2	**3 (Fig. 29)**
51. *Macromidia genialis buusraaensis*	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	2	-
52. *Macromidia rapida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**	2
Libellulidae																	
53. *Acisoma panorpoides*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
54. *Aethriamanta gracilis*	-	-	-	-	-	-	-	-	-	1♂	-	**1♂**	-	-	-	-	-

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
55. *Brachythemis contaminata*	-	-	-	-	-	3	3	-	-	2	3	2	-	2	-	-	-
56. *Brachydiplax chalybea*	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-
57. *Brachydiplax farinosa*	-	-	-	-	-	2	-	-	-	-	-	**3**	-	3	-	-	-
58. *Cratilla lineata calverti*	-	-	-	-	-	-	-	-	-	-	-	-	1♀	-	-	-	-
59. *Crocothemis servilia*	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-	-
60. *Diplacodes nebulosa*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
61. *Diplacodes trivialis*	-	-	-	-	-	-	1♀	-	-	-	-	3	1♂	-	-	-	-
62. *Hydrobasileus croceus*	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-
63. *Indothemis carnatica*	-	-	-	-	-	-	-	-	-	-	-	**3 (Fig. 30a-b)**	-	-	-	-	-
64. *Indothemis limbata*	-	-	-	-	-	-	-	-	-	-	-	**3 (Figs 21, 30c)**	-	-	-	-	-
65. *Neurothemis fluctuans*	-	-	-	2	-	4	3	-	-	-	-	1♂	-	-	2	-	-
66. *Neurothemis fulvia*	-	-	-	-	-	-	-	-	1♂	-	-	1♂	2	2	-	-	1♂
67. *Neurothemis intermedia atalanta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
68. *Onychothemis culminicola*	-	-	-	-	-	-	-	3	3	2	-	-	-	-	-	-	-
69. *Onychothemis testacea*	-	-	-	-	-	-	-	1♂	2	-	-	-	-	-	2	-	2
70. *Orthetrum chrysis*	-	-	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-
71. *Orthetrum luzonicum*	-	1♂	-	**2 (Fig. 31)**	-	**2**	-	-	-	1♂	**1♂**	-	-	-	-	-	-
72. *Orthetrum neglectum*	-	-	-	1♂	-	-	-	-	1♂	-	-	1♂	1♂	-	**1♂**	-	-
73. *Orthetrum glaucum*	-	-	-	**2**	-	-	-	-	1♂	-	-	-	-	-	-	-	-
74. *Orthetrum sabina*	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-
75. *Orthetrum triangulare*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂
76. *Palpopleura sexmaculata*	-	-	-	**1♀**	-	-	1♂	-	-	-	1♂	-	-	-	-	-	-
77. *Pantala flavescens*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
78. *Potamarcha congener*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
79. *Pseudothemis jorina*	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
80. *Rhyothemis phyllis*	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
81. *Rhyothemis plutonia*	-	-	-	-	-	-	-	-	-	2	-	-	2	3	-	-	-
82. *Rhyothemis triangularis*	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
83. *Tetrathemis sp. (?platyptera)*	-	-	-	-	1♂	-	-	-	1♂	-	-	-	-	-	-	-	-
84. *Tholymis tillarga*	-	-	-	-	-	2	-	-	-	-	3	-	-	-	-	-	-
85. *Tramea transmarina euryale*	-	-	-	-	-	-	-	-	-	-	-	**3 (Fig. 32)**	-	-	2	-	-
86. *Trithemis aurora*	-	-	-	-	-	-	-	-	-	2	4	4	4	4	2	2	-
87. *Trithemis festiva*	-	1♀	-	2	-	2	-	-	-	-	-	-	3	-	-	-	-
88. *Urothemis signata*	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-
89. *Zygonyx iris malayana*	-	-	-	1♂	-	-	-	3	2	-	-	-	3	-	3	-	2
90. *Zyxomma petiolatum*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

species that is a comparable to 90 species found in Mondulkiri Province in 6.5 days.

The richest place was the swamp of M12, not studied before, which offered 30 species for two hours of examination. (*Trithemis festiva* (Rambur, 1842) was mentioned for this place in (Kosterin 2018b) in error.)

Macromia flavocolorata Fraser, 1922 (Figs 27-28) is a new country record for Cambodia. The species for the first time found in Mondulkiri Province and not included in its preliminary checklist (Kosterin 2016) are *Lestes nigriceps* Fraser, 1924 (Fig. 18), *Diplacodes nebulosa* (Fabricius, 1793), *Indothemis carnatica* (Fabricius, 1798) (Fig. 30a-b), *I. limbata* (Selys, 1891) (Figs 21, 20c), all found in the swamp of M12 and already mentioned in (Kosterin 2018b). Note changes in taxonomic treatment/identification of some species accepted in this paper (Table 2) as compared to Kosterin (2016): *Euphaea inouei* Asahina, 1977 (Figs 19-20) for *E. masoni* inouei; *Euphaea sanguinea* Phan, Kompier, Karube et Hayashi, 2018 for '*E. ochracea*' (Phan et al. 2018), *Microgomphus alani* for the misidentifications '*Microgomphus jurzitzai*' and '*Heliogomphus* sp. cf. *svihleri*' (Kosterin 2019); *Macromidia genialis buusraaensis* for *M. genialis* ssp. (Kosterin 2018a).

Remarks. 1. In 2018 I managed to collect a topotypical male (Figs 24) and female (Fig. 25) of *Asiagomphus reinhardti* Kosterin et Yokoi, 2016 in its type locality, which is M17 ('Loringae brook'). The original description was based on the holotype male from that place collected in 2014 and

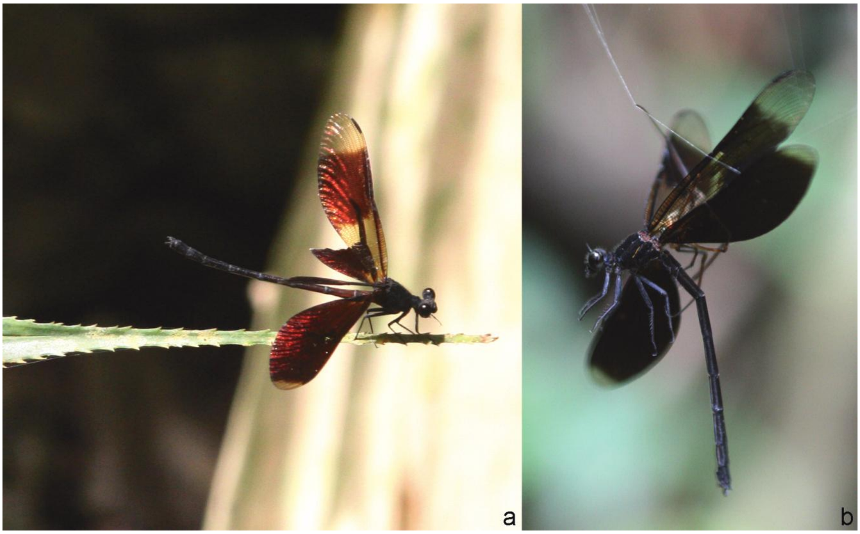

Figure 19. Males of *Euphaea inouei* at the 'Loringae brook' downstream of the Buu Sraa Waterfall (M17). 24.06.2018.

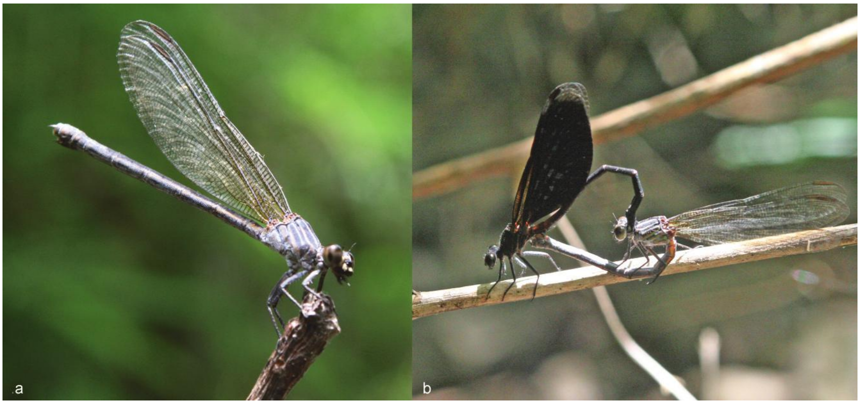

Figure 20. A female (a; M13; 26.06.2018) and copula (b; M16; 25.06.2018) of *Euphaea inouei*.

a paratype male from Laos, Champsak Province, Paksong (Kosterin & Yokoi 2016). These two specimens differed in presence (the holotype) versus absence (the paratype) of the antehumeral stripes and the yellow markings on the metepisternum and the size of the lateral yellow spots on S8 (considerable in the holotype versus tiny in the paratype). The characters of the newly obtained topotypical male (Figs 24b) was as in the holotype, with the mentioned yellow markings a bit smaller.

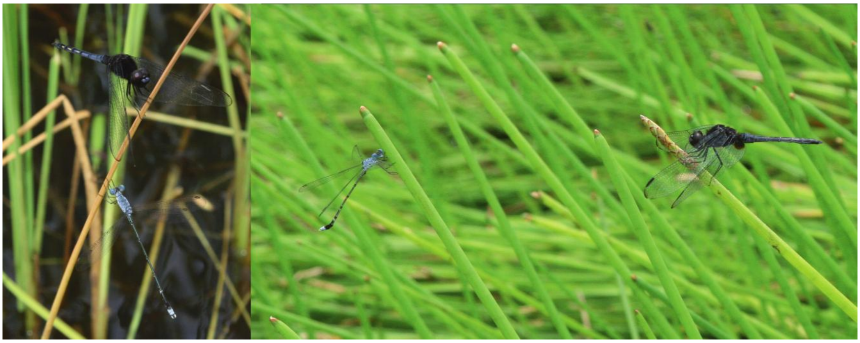

Figure 21. Males of *Lestes praemorsus decipiens* and *Indothemis limbata* the large grassy swamp 15 km NNE of Sen Monorom (M12). 27.06.2018.

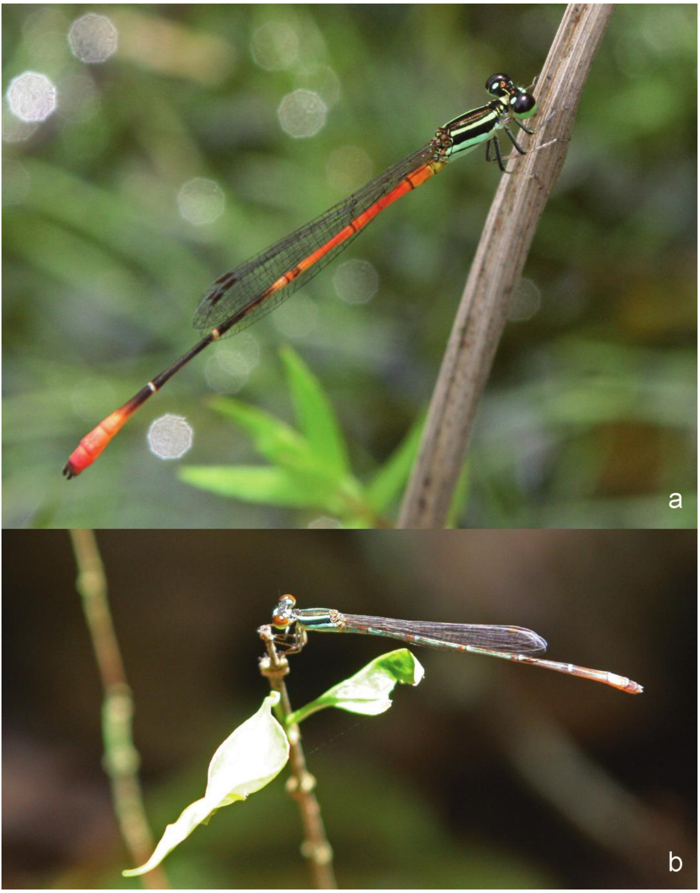

Figure 22. Young male (a; M12, 27.06.2018) and female (b; OS2; 21.03.2019) of *Argiocnemis rubescens rubeola*.

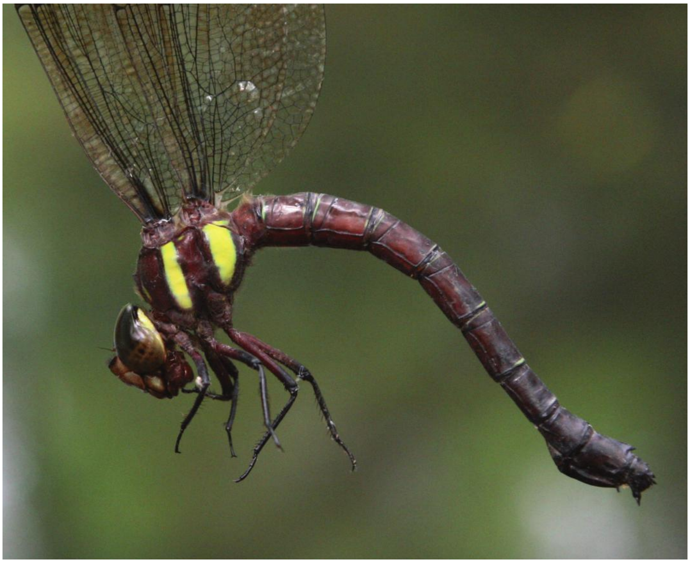

Figure 23. A female of *Tetracanthagyna waterhousei* from the river 16 km NNE of Sen Monorom (M13). 27.06.2018.

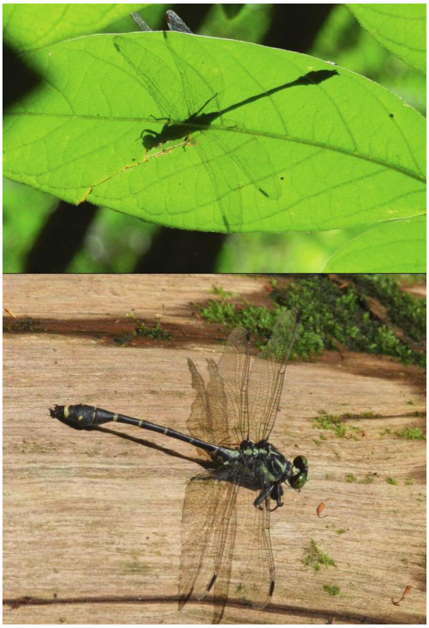

Figure 24. A topotypical male of *Asiagomphus reinhardti* in nature in the species' type locality, the 'Loringae brook' downstream of Buu Sraa Waterfall (M17). 24.06.2018.

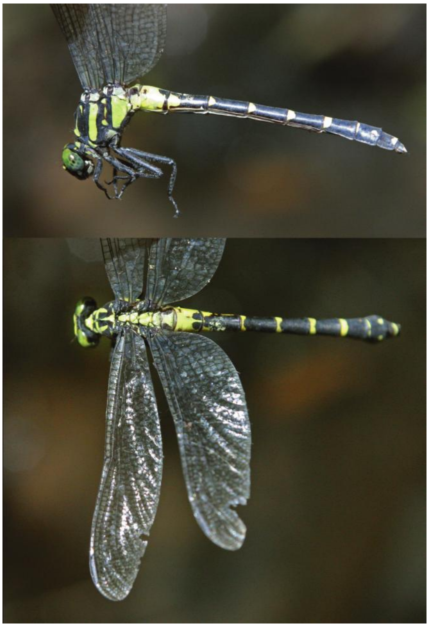

Figure 25. The topotypical female of *Asiagomphus reinhardti* (from M17). 24.06.2018.

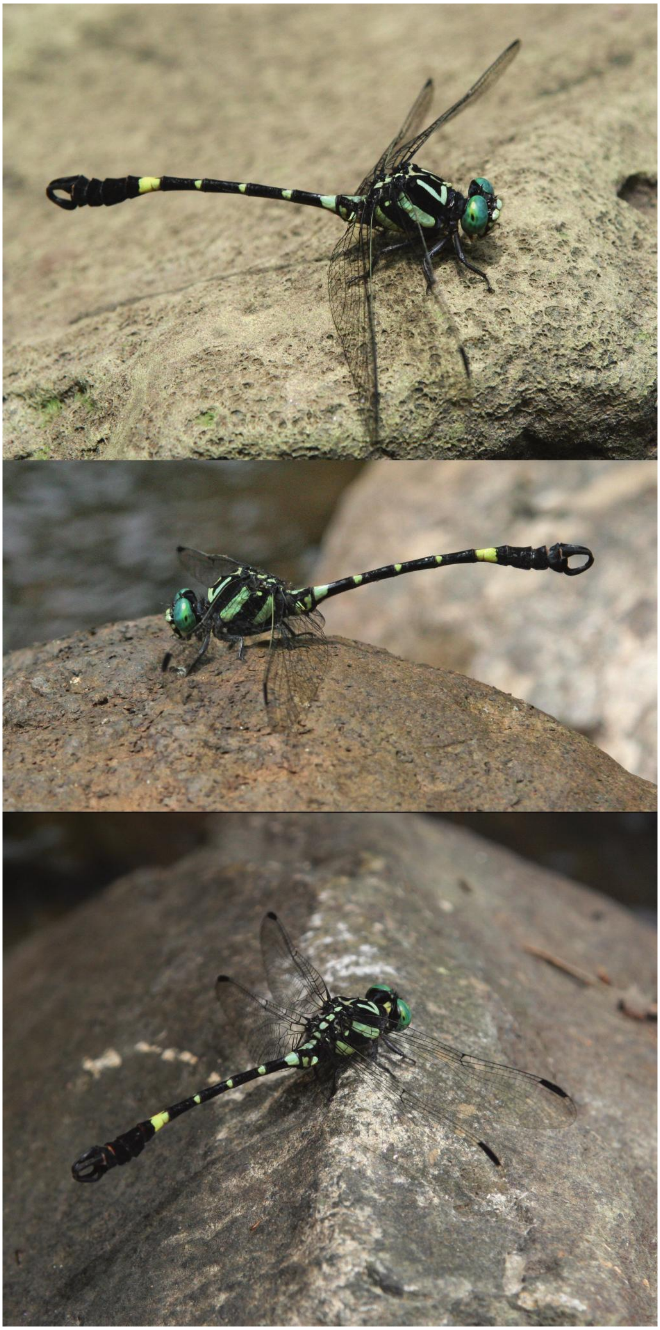

Figure 26. Males of *Lamelligomphus castor* from the right tributary of the ?Pulung River (M16). 25.06.2018.

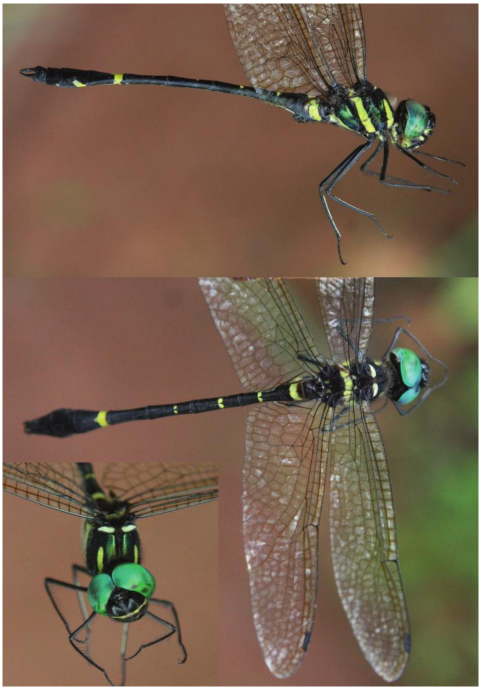

Figure 27. A male of *Macromia flavocolorata* from the ‘Ochracea rivulet’ (M9), a left tributary of the river with the Monorom Waterfall. 23.06.2018.

The female sex of this species was later described by Kompier (2018) from three females from Vietnam, one from Bao Loc Province (southern Vietnam) and two from Gia Lai Province (central Vietnam). He provided the following diagnosis for the *A. reinhardti* female: “Structurally the most prominent is the lack of the connection between the ridge that connects the lateral ocelli and the margin of the compound eyes. ... Other features that support the identification are the yellow lines along the anterior margin of 8 and the longitudinal mid-dorsal line over S10” (Kompier 2018: 322). The topotypical female (Fig. 25) shows the two former characters but not the last, as having S10 completely black. The three Vietnamese female specimens showed considerable variation with respect to the maculation of the labrum, mesepisternum, metepisternum, S2 and S10, the colour of the cerci and also the expression of the spikes between the lateral ocelli and eye margin and the knob of the occipital plate (Kompier 2018). The topotypical female (Fig. 25) has two small yellow spots at the base of labrum; antehumeral streaks in the upper half of the mesepisternum; the metepisternum

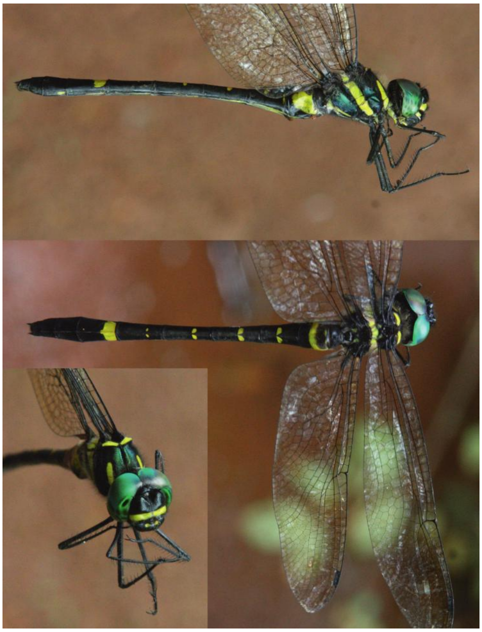

Figure 28. A female of *Macromia flavocolorata* from the ‘Ochracea rivulet’ (M9), a left tributary of the river with the Monorom Waterfall. 23.06.2018.

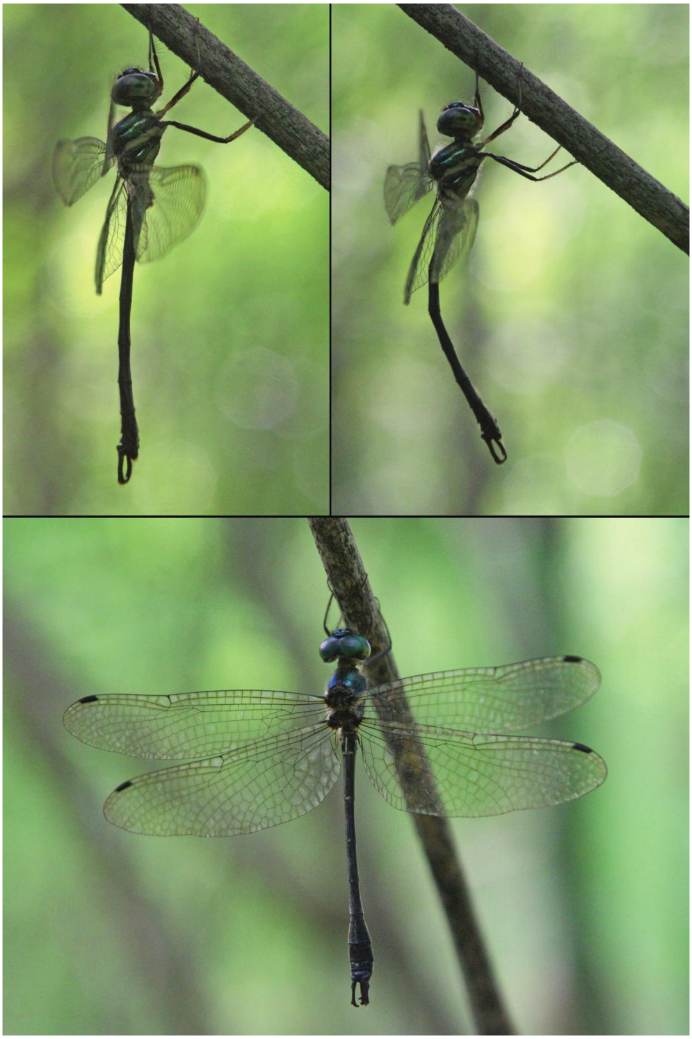

Figure 29. A male of *Idionyx thailandica* under the forest canopy over the 'Loringae brook' downstream of Buu Sraa Waterfall (M17) at the end of the day of 24.06.2018.

with a large yellow spot behind the spiracle and a continuous yellow stripe above it, which is composed of two large bulges at its lower and upper ends and a very narrow central part; S8 with small lateral yellow spots; the cerci yellowish above and brownish elsewhere. The central occipital knob is much smaller than illustrated by Kompier (2018: fig. 9f), and there is a trace of a lateral knob at the middle of the left side of the occipital plate margin; the 'spikes' (actually blunt, squarish-rounded processes) dorsolaterad of the lateral ocelli as illustrated (Ibid.). Hind wing 38 mm, abdomen 43.5 mm. These characters, except for the absence of S10 yellow marking, are within the variation described for the three Vietnamese females by Kompier (2018).

Two males of A. *reinhardti* were met in the type locality on 24.06.2018 at the same place as the holotype on 15.06.2014: about the middle of the 'Loringae brook' reach between its waterfall and the mouth, surrounded by tall evergreen forest. Both perched on boulders or logs (Fig. 24b) at the stream (the holotype did the same, see Kosterin & Yokoi 2016: fig. 1), when startled one of them relocated to a leaf at ca 2 m above the ground (Fig. 24a). A female was found in the same place while hovering above the water (it differed at distance from *Lamelligomphus castor* Lieftinck, 1941, which is fond of hovering, in having more yellow and a club-shaped abdomen).

2. Of the two collected males of *Burmagomphus divaricatus* Lieftinck, 1964 one had no additional denticles on the posterior hamulus, as in the original description (Lieftinck 1964) while the other had two additional denticles. This character is variable in this species in Cambodia (Kosterin 2014; 2016; 2020b).

3. Unlike a number of Cambodian populations of *Idionyx thailandica* Hämäläinen, 1985 elsewhere, e.g. in Ratanakiri Province (Kosterin 2014) or the Phnom Kulen Mts. (Kosterin 2020b), that in Mondulkiri Province did not exhibit shortage of males: of 9 specimens collected in 2018, 6 were males (Fig. 29); together with 5 specimens collected in 2014 (Kosterin 2016) this counts 8 males vs 6 females.

4. *I. carnatica* (Fig. 30a-b) and *I. limbata* (Figs 21, 30c) occurred together at the swamp of M12. The males were equally numerous and very active (*I. limbata* seemingly less cautious); copulae and ovipositing females were also seen. The collected specimens of *I. carnatica* (3 ♂♂) and *I. limbata* (1 ♂, 1 ♀) differ as follows: (i) the male appendages are brownish in the former and black in the latter; (ii) there are 9 ½ fore wing antenodals of the former and 11 ½ in the latter (both sexes); (iii) the former is slightly larger (hindwing 30 mm in the male and 32.5 mm in the female, abdomen without appendages 24-24.5 mm,

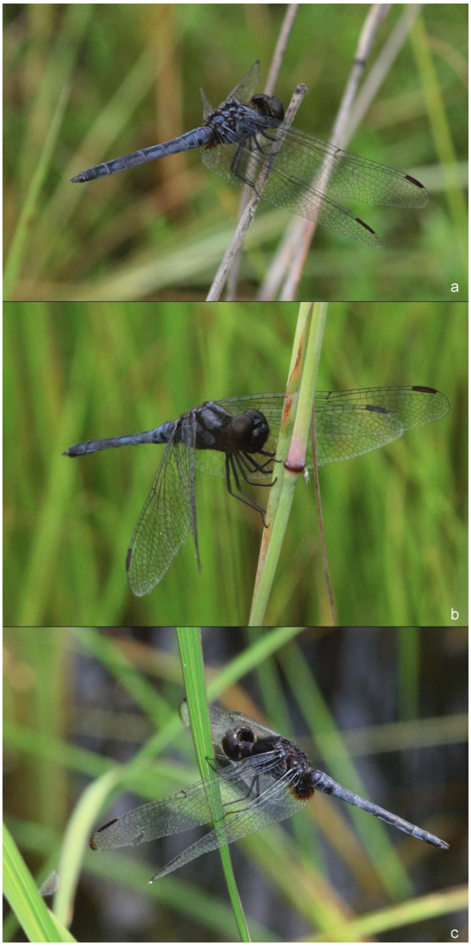

Figure 30. Males of *Indothemis carnatica* (a-b) and *Indothemis limbata* (c) at the large grassy swamp 15 km NNE of Sen Monorom (M12). 27.06.2018.

versus hindwing 28-28.5 mm and abdomen 22-23 mm in *I. limbata*). These differences rather correspond to those given by Fraser (1936) but for *I. carnatica* (as *Indothemis caesia* (Rambur, 1842)) he stated dull-ochreous appendages and 8 ½ antenodals (versus 10 ½ - 12 ½ for *I. limbata*). In the collected males of *I. limbata*, the dark rims of the wingtips, also considered by Fraser as a specific character, are very narrow in two males (Figs 21, 30c) and absent in the third one. The living males of *I. limbata* (all which I saw in Cambodia) have a bright blue spot while Fraser (1936: 341), maybe based on collected specimens, mentioned only "purplish-steely reflex".

Observations. 1. *E. sanguinea* always perched in shade and rarely flew, while *E. inouei* perched both in shade and sun and was much more active.

2. *M. flavocolorata* (Figs 27-28) were found to be remarkably confined to a specific place at the 'Ochracea rivulet' valley (M9) 66 m from its mouth: a tiny lateral brook, situated under a slope disturbed by an excavator (12.44165°N, 107.16108 E). It was just several metres long, shady and sluggish, with sucking bottom of red mud formed by a ground washed down from that disturbed slope, with sparse *Cyperus* sp. I was there

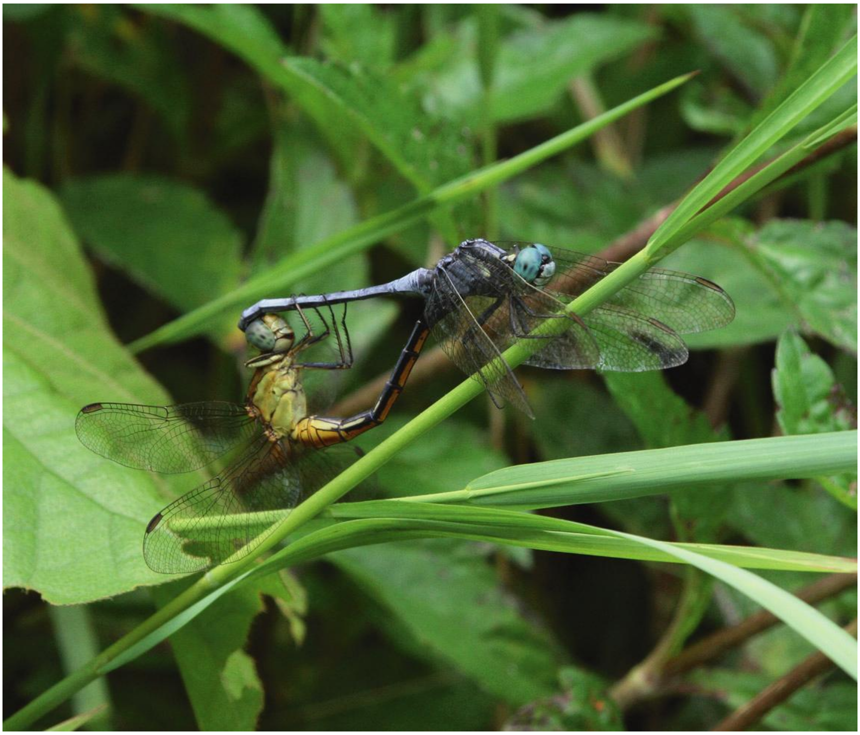

Figure 31. A copula of *Orthetrum luzonicum* at a damp meadow near a dam at the O'Romis River (M4). 28.06.2018.

since 9:40 to 10:00 a.m. First a female appeared which started to fly to and fro very low and for very short distance not more than 1 m; when I caught, it another one appeared in the same place almost immediately. After I caught it as well, several males appeared at the same place one after another, which ranged faster, higher (ca 1 m high), and for a larger distance of 2-3 m. I caught three males but I often missed strokes so more males appeared in fact. Besides, above the same place not less than two males of *Zygonyx iris malayana* Laidlaw, 1902 appeared, a male of *Onychothemis culminicola* Förster, 1904, a male of *Orthetrum neglectum* (Burmeister, 1839) and a male of *B. divaricatus* sat on the mud. Some males of *M. flavocolorata* appeared at a bit more upstream place of this brook, without mud; there I caught also a male of *Macrogomphus kerri* Fraser, 1922. When I revisited this place at ca 13:30 p.m. I did not see any of the above species but collected a male of *Euthygomphus schorri* Kosterin, 2016 and saw a male of *Neurothemis fulvia* (Drury, 1772). I had no idea why this tiny strip

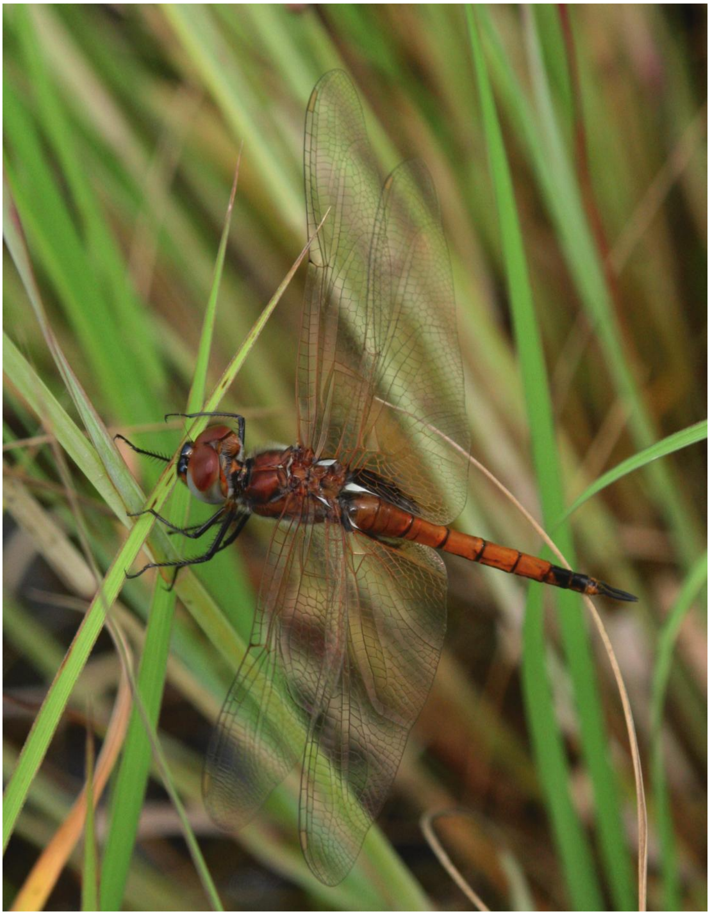

Figure 32. A male of *Tramea transmarina euryale* at the large grassy swamp 15 km NNE of Sen Monorom (M 12). 27.06.2018.

of shaded mud from a disturbed slope of an otherwise natural woody valley attracted so many diverse dragonflies in the morning; I did not observe anything like this elsewhere. This especially concerned *M. flavocolorata*, both sexes of which apparently formed a queue to fly over it. In Koh Kong Province I observed males of *Macromia septima* Martin, 1904 to range along an open river bank with disturbed ground (Kosterin 2014).

3. Earlier I supposed that in Mondulkiri Province, *Onychothemis culminicola* and *O. testacea* Laidlaw, 1902 tend to exclude each other since I did not observe them together (Kosterin 2016). This was not the case in 2018 when I observed both species together at the river with Monorom Waterfall (M8) and its tributary 'Ochracea rivulet' (M9) on 23.06.2018.

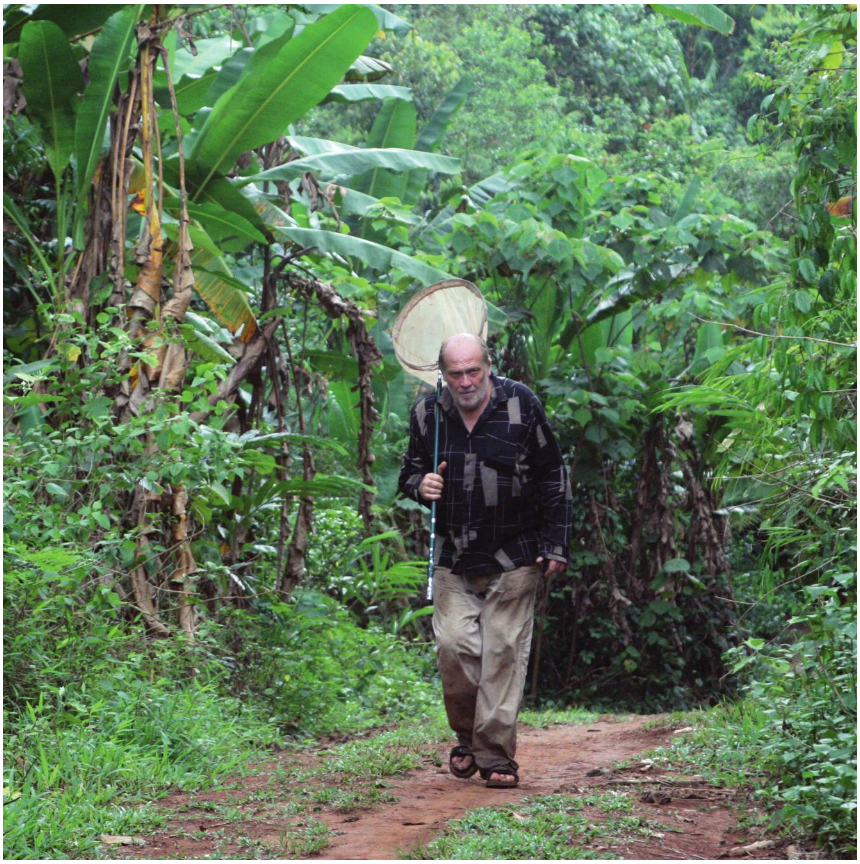

Figure 33. Banana plantations penetrating into evergreen forest ca 8 km SSW of O'Som village. 21.03.2019. Photo by a local guide.

IV. O'Som vicinities

O'Som (Veal Veang District, Pursat Province) used to be a desolate village surrounded by vast evergreen rainforest and situated on very gentle, moderately elevated (400-600 m a.s.l.) sandstone terrain, actually a low plateau, being part of the Cardamom Mts. Until the end of 1990s it was one of the last strongholds of Khmer Rouge, so that for long it was hardly accessible by a muddy road crossing the Cardamoms. Everything has changed recently. A good road from Koh Kong City to O'Som was constructed to serve to several hydropower stations constructed by Chinese firms, with accompanying small towns, tall dams and vast water reservoirs with partly cleared, partly dead forest at lifeless banks. The largest one, some 6×7 km, is situated north of O'Som. The last patches of rainforest had been just cut and were still burning when I visited the village on March 20-21, 2019. The area is now occupied by young plantations among burned stumps and trunks of what recently was a vibrant forest. Yet there is one of the few remaining population of the Siamese Crocodile (*Crocodylus siamensis* Schneider, 1801) at a forested river in not far from O'Som, attracting a lot of tourists. Curiously, the nearly pristine rainforest still exists in most of the more southerly Koh Kong Province, and it is the Pursat Province territory which is dramatically devastated. The scarcely disturbed evergreen forest is retained along the Koh Kong Province border, some 6–13 km S of O'Som, which was a target of my day long trip of 21.03.2019. This was a gentle hilly terrain clad with continuous forest with a big rapidous river over a sandstone bed, dark slimy forest brooks and banana plantations under tall trees (Fig. 33) remained from the forest at its border.

Localities and Odonata therein:

OS1: 6 km SE of O'Som village, a rivulet with scarce forest remnants after fresh logging; young plantations around. 12.034°N, 103.233°E, 519 m a.s.l., 20.03.2019, ca 1:30 p.m., partly cloudy before thunderstorm. Many: *V. gracilis*, *P. rubriceps* Selys, 1876; several: *Heliocypha biforata* (Selys, 1859); few: *Copera vittata* (Selys, 1863) (1 ♂ seen), *Prodasineura autumnalis* (Fraser, 1922) (1 ♂ collected), *P. verticalis* sensu Asahina, 1984 (1 copula collected, 1 more ♂ seen), *N. fluctuans* (1 ♀ seen). A big male of Macromiidae indet. (perhaps *Epophthalmia* sp. but not *E. frontalis* Selys, 1871 since black rather than reddish), ranged over a brook flowing through a sucking ashy ground left from the burnt out forest. A female of seemingly the same species oviposited while ranging very fast above a short stretch of this brook; then in a very small pool among dry branches. The males appeared twice but I missed a net stroke; the female also appeared twice and I managed to hit it with the net but it fell onto the water and managed to fly away. So sad losses of unidentified dragonflies from an interesting family, which exhibited reproductive behaviour at their already killed habitat and surely no more exist there.

OS2: 9 km SSW of O'Som village, a sluggish brook in a shady valley hard to penetrate into and hidden in primary evergreen forest, the water flowed well in the morning but almost disappeared in the afternoon. 11.999°N, 103.188°E, 479 m a.s.l. 21.03.2019. Very many: *V. gracilis*; many: *C. vittata* (mature and at the ghost stage, 1 ♀ collected); several: *H. biforata, Rhinagrion viridatum* Fraser, 1938 (3 ♂♂ seen, 1 collected), *Or-*

thetrum chrysis (Selys, 1891); singular: *Coeliccia kazukoae* Asahina. 1894 (1 ♂ released), *Orchithemis. pulcherrima* Brauer, 1878 (♂ collected). At the open place where the brook crossed the road there were *N. fulvia* and *N. tullia* (Drury, 1773) (1 ♂ of each) and a very cautious male of *Macrogomphus kerri* (poorly photographed) perched on thin branches at the road. Further along the shady poor road through the forest many *V. gracilis* and *Cratilla lineata calverti* Förster, 1903 occurred, and three females of *R. rubescens rubeola* Selys, 1877 (Fig. 22b) (collected) were unexpectedly found in low and sparse herbage (Fig. 22b), two of which resting on neighbouring stems.

OS3: 12.5 km SSW of O'Som village, a big rapidous river in a broad sandstone bed flowing through primary evergreen forest, 11.972°N, 103.180°E, 413 m a.s.l. 21.03.2019. At the river sunny banks there were many: *Neurobasis chinensis* (Linnaeus, 1758), *Zygonyx iris malayana*, *Heliocypha perforata limbata* (1 ♂ collected); several: *P. rubriceps* (3 ♂♂ seen), *P. autumnalis*; singular – *H. biforata*, *Dysphaea gloriosa* Fraser, 1928, *Euphaea masoni* Selys, 1859, *T. aurora* (Brauer, 1865) (1 ♂ of each seen); in shade many *V. gracilis* and *C. vittata*.

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